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A NEWLY DISCOVERED PORTRAIT OF MOZART.

NOT a single one of the numerous portraits of Mozart known hitherto bears the stamp of perfect authenticity. The several pictures representing the great musician show very strong differences in the features and in the expression. The few which it has been proved have been painted after nature were as little faithful representations of the original as those sketched in haste or those painted from memory. Hitherto only a conventional representation of Mozart has been known, the inspection of which produced on any person of refined sentiments the impression that Mozart's appearance must have been different. No one more keenly felt the want of an authentic picture of Mozart than the author of the nearly completed Mozart monument of Vienna. Tilgner, who usually is so sure of hitting the mark, and so easily performs his work, was busy for years in shaping Mozart's head, until he finally found a solution which would satisfy him. But even then he had some slight disquieting doubt if the Mozart he had modeled after the image of his fancy and enthusiasm, and which he intended to place on a pedestal, was an artistically transfigured yet faithful portrait of the great master Wolfgang Amadeus. As to the artistic effect of his Mozart, he was sure of it, this being warranted by the unanimous admiration of the laymen and the connoisseurs.

The question of resemblance has, however, also been decided, and in a manner which afforded high satisfaction to the artist. One day, as he was going

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to give the last touch to Mozart's head, a young man asked the permission of inspecting the atelier. At the sight of the model for the Mozart monument, he remarked that one of his friends owned a picture which was said to be a portrait of Mozart. The next day the picture was already in Tilgner's possession. It proved to be not merely the best, but probably the only authentic one of all known portraits of Mozart. The pastel picture is executed three-fourths of natural size by an excellent artist, but is not signed; in one of the corners, however, are placed the initials W. M., between them a treble key, and below the date 1786. The interpretation which at once occurs to the mind is Wolfgang Mozart, painted in 1786, that is to say, five years before his death. Mozart is represented in profile, with slightly powdered, loosely arranged hair; the collar of the light blue dress coat, the front part of which is partly covered by the corners of a white shirt, reaches high up the neck. A delicate, intellectual, freshly-colored face, steady-looking eyes, a somewhat low but characteristically modeled forehead, a strong, protruding nose, a little mouth with a child's lips, and a small, softly-rounded chin provided with dimples form an ensemble of a very characteristic individuality. In comparison with the strength expressed by the upper part of the face the lower part produces a really childlike impression. The general expression of Mozart's physiognomy is very strikingly described by L. Ganghofer in a few words: These features almost look as if they were composed of two faces, that of a man and that of a child.

The features which are only indicated or misrepresented in other portraits of Mozart are united in this picture to form a life-like resemblance. It may be cited as a proof of remarkable artistic intuition that the Mozart modeled by Tilgner is a perfect likeness of a picture painted from the life by a skilled artist.—*Illustrirte Zeitung.*

VOCAL PHYSIOLOGY AND SYSTEMATIC VOICE TRAINING FOR THE PREVENTION OF DISEASES OF THE LARYNX.*

By J. WALTER PARK, M.D., Harrisburg, Pa.

THE State Medical Society of Pennsylvania, in 1883, passed a resolution that there should be annual alternating addresses on the subjects of ophthalmology, otology and laryngology, but for various reasons laryngology was omitted in 1889. Hence the first and last address on this subject was delivered by my esteemed friend Mr. Charles E. Sajous, of Philadelphia, in this city, seven years ago. In looking over his very able address, I notice he pointed out to you the importance and relationship of laryngology to the general practitioner, as well as some of the advancements in laryngology up to that time. I will endeavor to-day to give you a continuation of the advancements on this subject, but in a somewhat different line of thought, viz., the necessity of systematic physical voice training in our public schools and colleges for the prevention of some of our most prevalent diseases of the larynx. This subject has lately been considerably agitated by some of our most eminent specialists in England, France, Germany, Scotland, Ireland and America, and no doubt will sooner or later result in the systematic teaching of the proper methods of breathing and speaking in our primary schools and the systematic training of the voice in all academies, colleges, and higher institutions of learning. The object of this paper will be at least in a measure attained, if I can arouse sufficient interest in the medical profession in general, that they will give this subject serious consideration, and advocate its principles among parents and heads of families who have children attending schools and colleges, for by so doing good results are sure to follow. If the governing and controlling powers of institutions of learning have their attention called to this subject by physicians and scientific men in general, quacks or charlatans can no longer impose upon the credulity of the public by traveling around through the country teaching false methods, etc., when most of them do not even know the first principles of systematic voice training.

Let us take the child in its infancy as an example to begin with; when it first begins to utter audible sounds it tries to imitate its mother, nurse, or teacher, and tries very hard to formulate sounds into intelligible speech. Years are required to teach a child to phonate properly. Parents should, therefore, devote a great deal of their spare time in teaching their children how to formulate sounds into words and articulate them properly, for by so doing they assist them in acquiring more easily and quickly that which otherwise they would not acquire except by a great deal of extra hard labor. At the age of four to six years a vast amount of good can be accomplished by the parents previous to sending them to school, in the various breathing exercises and the proper method of pronouncing words, and to correct them for every slang phrase they may utter. When a child is sent to school, it is generally taught the art of writing by the proper co-ordination of its muscles in using the hand, as well as the proper position of the body while at its studies. If we thus teach them the proper method of using the muscles of the hand and body, why should we not have a teacher of vocal physiology to teach them the proper method of breathing, by chest, nasal and respiratory exercises, opening and closing the mouth, the modulation of the voice, etc., pronouncing words properly while in the act of phonation? This training should begin in the primary schools, and be continued with the proper advancements in the art, as the child advances in its studies, and extended to the time it has completed its collegiate education. There are very few colleges to-day that properly train the vocal powers of their students, and as a result a good orator or elocutionist is seldom found among their graduates; and likewise there are seldom heard on the pulpit, the platform, the stage, and at the bar, men who as specimens of physical voice training are able to speak for an hour or two and not suffer hoarseness or fatigue of their vocal organs. That is the time they should have full control of the respiratory movements of their lungs, know how to attack words at a proper pitch of the voice, and how to control their vocal cords, etc., without producing fatigue and congestion of the larynx and pharynx, which always follows when not judiciously used. Violently exercising the voice in the wrong register, and in an improper tone of the voice, must eventually produce physical harm or disease to some parts of the larynx.

The physician must first skillfully perform his duty in seeing that the pupil can perform the proper nasal respiratory movements, by examining his nose and naso-pharynx, and removing all adenoid vegetations, and treating any existing hypertrophic rhinitis, or hypertrophy of the tonsils; as well as take notice if there are any existing anatomical malformations which might interfere with the development of proper articulate language. Stammering is almost always a result of failure to observe properly, and of improper methods of teaching a child. The naso-pharyngeal diseases referred to are also occasionally causes. The physician and specialist should first call attention to and point out all defects in an anatomical, physiological and pathological point of view, and if possible correct any existing defects and then place the pupil in the hands of the scientific voice trainer. Pharyngitis is often produced by spasmodic, jerky respiratory movements while in the act of attacking a tone, and by not knowing how to economize the breath that is inhaled, thereby producing false, harsh and congested tones. Raising the pitch of the voice without raising the voice itself is another frequent cause of congestion of the larynx. The part that should be cultivated is the natural tone of the voice in which a person speaks with the least effort. Lenox Browne says: "The lungs are the motors of respiration; the larynx the vibrating organ, and the chest, walls, trachea, pharynx and naso-pharynx the resonating apparatus." The French actor Talma always madeta habit of speaking in his ordinary tone of voice behind the scenes to some of his fellow actors previous to appearing on the stage, so that he could maintain the same pitch in his voice. This is an excellent habit for all clergymen and public speakers to form. Pharyngeal and laryngeal diseases would be an exception rather than the rule if this were universally put into practice. Madame Seiler says that "if the physiology of the voice were better known and acted upon, there would be few complaining singers and speakers." There is no doubt that the solid basis of the voice is a systematic and proper method of breathing; establish that first, and then begin the systematic training of articulate speech. Dr. Gordon Holmes describes the benefits of vocal practice as follows: "The general well-being of the constitution is promoted by voice practice because the wider chest movements accelerate the circulation of the blood, at the same time that they cause a more ample flow of fresh air in and out of the lungs. The obstacle of expiration offered by the contraction of the glottis during phonation confers a greater penetrating power on the pulmonary air, which perforce permeates the minute bronchi, and distends the air vesicles of the lungs more effectively; thus the blood attains a higher oxygenation and greater purity, by which qualities it gains in power of stimulating the vital activities of the various tissues of the body as it courses through them. Effete matters are freely cast off, and new and wholesome material is assimilated in increased amount. The appetite, so to speak, of the various corporeal structures becomes more keen, and they are thus subjected to an exalted nutrition. And, moreover, these effects have a certain permanency on account of the gains to the thoracic capacity, derived from the habitual increase of lung expansion necessitated by constant vocal exercise." Chest and laryngeal exercises in a systematic way accomplish some of the same results that are derived from a visit to the higher altitudes, such as Texas, Mexico, Southern California, Colorado, etc.

The question is frequently asked at what age should a child begin to sing or have its voice trained. Opinions differ materially on this question. Patti was taught systematically by her half brother Barilli, and first appeared in concert singing at the age of seven years. She sang in concert with trained singers. Nilsson was sent to Wartel when quite young. Jenny Lind was trained for the stage at nine years of age, and (it is supposed), from forcing her voice, lost it at the age of twelve years, but regained it at the age of sixteen. Others who lost their voices in a similar manner suffered from a paralysis of the arytenoid muscles of the larynx, or vocal ligaments. Manuel Garcia was her trainer after her recovery, and the "Swedish Nightingale" soon became one of the world's most renowned singers. Listen to the child as it tries to sing one of its nursery songs; notice the tone and pitch of its voice, and you will soon be able to judge the voice compass; carefully watch it and see that this compass is not exceeded by willful exertions on the part of the child. If it is, stop it at once; if not, allow it to go on by your assistance as much as possible, always being careful that it wearies not in well doing.

You will notice from these remarks that there is no set time for a child to begin to sing or have its voice trained. That question should be left for your teacher in vocal physiology or voice trainer to decide.

Another mooted question is, whether a child should sing in a concert or not. Wartel says, "If a child is possessed of a note worth training, let it sing in a voice concert." By analyzing carefully the opinions of a great many voice trainers we arrive at this conclusion: If a child has an exceptionally fine voice, which by special training would develop into an artistic one, never let it sing in concert until after it has been systematically trained and well developed in all the registers; it cannot well go wrong after that. To preserve the sweet and natural tones of the child, to fit it for the stage, the platform, or the bar, it must be carefully and physically well trained when young, and it will then develop into a sweet-toned singer or an eloquent and brilliant orator, and you will thus save many a child from some pharyngeal or laryngeal disease, which it otherwise might have acquired by first singing in concert, previous to having any physical training. Many "might have been" famous singers are never heard, principally on this account.

If you thus carefully develop the delicate muscles of the larynx under the guidance of a scientific trainer, as the athlete trains the muscles of his body previous to entering the race, you not only assist in developing a nation who talk well and sing sweetly, but you assist in saving thousands of people from a premature grave to which they are otherwise inevitably doomed. Vocal physiology and systematic voice training are just as necessary as physical training as a part of the athlete's daily work.

I do not pretend to say that all who follow these suggestions will never suffer from a cold, a sore throat, or an acute attack of largyngitis or pharyngitis at some time or another; but the probabilities are that fifty per cent. of the people who are obliged to consult the laryngologist now would not be obliged to do so were these suggestions rigidly enforced and observed. The most frequent and common ailments of the voice user from which one may suffer at some time or another are the following: Catching cold, sore throat, or relaxed throat, acute and chronic pharyngitis, chronic granular pharyngitis, elongated or relaxed uvula, tonsilitis, and acute and chronic laryngitis.

Having considered the physical necessity of vocal physiology and voice training, some remarks upon the daily life of the voice user, in order to assist in the prevention of laryngeal diseases, are quite applicable before closing this paper.

Most of our eminent authors say that a man's life is controlled 1st, by residence; 2d, by ablutions; 3d, by clothing; 4th, by diet; 5th, by exercise; 6th, by amusements; and lastly by individual habits.

First, Residence.—It is very important that a man or woman who wishes to preserve a good voice should live in well ventilated rooms. They should not sleep in the same rooms they occupy during the day. They should be ventilated by day as well as by night. Drainage should be perfect, so as to prevent any exhalations from being inhaled, for their injurious effects are soon noticed upon a sensitive and congested larynx. Your residence should be situated rather high and have a southern exposure if possible. As regards climate, some require a dry and high altitude, while others feel best in a moist climate and low altitude. Some can live in smoky and dusty cities, while others must live elsewhere. This should be determined by the advice of your family physician and laryngologist.

Second. Ablutions.—This is a subject much debated upon and yet no strict rules have been laid down. The following are among the best. Daily baths are generally advised. In cold weather take a hot bath, rub the body freely with a flesh brush and plenty of soap (a coal tar preparation is the best for cleansing the pores and promoting action of the skin); then sponge the body or douche it with cold water while standing in the hot, and dry the major part of the body before taking the feet out of the warm water. If there is any fear of perspiration, you should lie between sheets for ten or fifiteen minutes before dressing. The Turkish bath to the singer has this advantage: the inspiration of hot dry air, which is so advantageous in counteracting the effects of cold, damp climates. It should be taken at least two hours after any meal. Put a wet towel on your head on entering the bath, to prevent heat stroke, palpitation, fainting, etc. Have the body shampooed lightly, and if perspiration is not active, drink a glass of water. Wash the head as well as the body. Do not take a cold bath immediately afterward, but douche first with water and have it gradually grow colder. Cool before dressing and keep the body and feet wrapped while cooling. Don't take a Turkish bath oftener than twice a week in winter and once a week in summer. Cleansing the mouth and teeth with cold water before singing and speaking should be practiced regularly. Bathing the throat and back of the neck with cold water is commendable, as it renders the skin less sensitive to cold draughts of air and prevents one from catching cold easily.

Third. Clothing.—A great deal might be said upon so very important a subject, but I will merely touch upon some of the most essential points. As it is customary when going out to put on a wrap of some kind, in the same manner when entering a room be careful to remove it. Try to keep the temperature of your body equalized, no matter where you are or where you go. If upon the stage, and rather lightly dressed, be sure to use your wraps while waiting in the dressing room between the acts.

The majority of singers and speakers should use silk or flannel underwear the entire year, especially if they are inclined to suffer from rheumatism. Others think that underwear woven in combination suits, extending from the neck to the wrists and ankles, made of silk, gauze, merino, or lamb's wool, is the best hygienic underwear that can be worn. It is especially advisable to protect the organs of secretion where damp and sudden climatic changes predominate. Regarding the covering of the neck, no singer should wear a collar that buttons above the level of the top of the sternum. The high collar of the dude, the high and tight collars frequently worn by ladies, are a great hindrance to singers and public speakers; their tendency is to constrict the throat and prevent free movement of the laryngeal muscles and produce congestion of the larynx and vocal cords, tonsilitis, etc., and materially interfere with all the movements of respiration.

Fourth. Diet.—The two chief varieties of food necessary to maintain life are the nitrogenous and non-nitrogenous. The former is principally found in the meats and the latter principally in vegetables, starches, sugars, etc. Many vegetables and fruits contain nitrogen, such as apples, peas, white beans, etc., and for this reason vegetarians say we need eat no meats when all the nitrogen we need can be obtained from vegetables. Singers or speakers who do not take much exercise should eat meat sparingly, so as to prevent obesity. A singer should have an interval of about three to four hours and a speaker two hours between a full meal and the time they wish to sing or speak. Some singers or speakers become quite fatigued and tired out by the time they are half through with their evening's exercises; in such cases some beef tea or meat extracts between acts should be taken if possible: or what is still better, a raw egg seasoned with a few grains of salt and a few drops of vinegar swallowed whole fifteen or twenty minutes before using the voice, is an excellent tonic. This is exceedingly pleasant when the voice becomes dry from nervousness. Stimu-

* Read before the Pennsylvania State Medical Society, 1893.

lants such as champagne, whisky, brandy and the malt liquors should be used very sparingly, for the reaction that follows their use is generally of such a character as to produce a congestion of the vascular supply of the pharynx, and more harm results from their use than the good that is accomplished. "Mariani" wine, made from the cocoa leaf, has many valuable testimonials from eminent actors and singers, but it also should be used with extreme caution, for we all know its active and exhilarating principle is due to cocaine, and who wants to become its slave? Avoid all foods that favor flatulence and have a tendency to interfere with the respiratory movements, all nuts and condiments, peppers, pickles, curries, etc., which have a tendency to stimulate the vascular supply of the pharynx and larynx. At meals tea, coffee and cocoa should be drunk according to the taste and digestion of the person using them. As a rule they should be discarded. Numerous carbonated effervescing waters when pure are good. Kumyss is a very refreshing and stimulating drink. The light wines, such as claret, Burgundy, and light Hungarian wines, after a hard day's work are refreshing and recuperative, but total abstinence from alcoholic stimulants of any kind is the best advice I can give you.

Fifth. Exercise.—Speakers and singers should not neglect their walk in the open air for an hour or two every day. The exercise is frequently neglected for fear of catching cold, but by observing their manner of dress, exercising moderately, and not violently, is an essential which should never be forgotten. A want of sufficient daily exercise soon tends toward corpulency, and congestion of the various organs of the body is liable to be the result, and interfere materially with the movements of respiration.

Sixth. Amusements.—Swimming, shooting, skating, lawn tennis, fencing, etc., if practiced with moderation, are all advantageous. Limit the extent of all amusements to the moment that fatigue begins; if extended to the stage of exhaustion, evil results often follow.

Habits.—Cigarette smoking is a pernicious habit, especially to singers and speakers. Tobacco in all its forms should be abstained from, principally on account of the inhalation of its fumes into the lungs, and its deleterious effects upon the heart, respiratory movements, and upon the pharyngeal and laryngeal mucous membrane in general.

Each of the main points of my subject might be dwelt upon far more extensively, but, having touched upon the more prominent ones, I hope that some lasting and favorable impression has been made upon your minds, and that you all may in some manner do your part toward establishing a department for physical voice culture in our public schools and colleges, and by so doing, save many thousands of human lives from a premature grave, by the prevention of many of our most common laryngeal diseases.

AMERICAN LIFE AND PHYSICAL DETERIORATION.

It is apparent to any man who will take the trouble to think, that, no matter what the learning, the knowledge, the ability or genius of the individual may be, these rest on the animal, and that without the animal, and, still further, without the animal in health, they are as nothing. Let but a little splinter of bone, no larger than the head of a pin, press upon the brain, and the wisest statesman that ever moulded the destinies of nations, the greatest judge that ever proclaimed the majesty of law, may be less than a little child. Little as we know of him, the most significant fact in the life of Shakespeare is that he never seems to have had any illness worthy of mention. Men may be civilized, they may be educated, they may be governed by the highest ideals, yet under all and carrying all, even as the foundation carries the palace above it, is the animal, the creature with physical wants and governed by physical laws. In every act in life, in every thought for others, we have to reckon first with this animal. Nature has guarded it well. No act of the will usually is or can be as strong as an instinct, and the brain with its energy, its power of thought, its range of knowledge, is but the servant of the instinct of self-preservation. For while it is true that there have been men and women who have risen above this for the sake of truth, honor or love, they have been the exceptions which prove the general law. While the instinct of self-preservation has been implanted in the animal in order to guard the individual, the second strongest instinct in existence insures the continuance of the race. As the first, so is this a purely physical thing: something which may be over-ridden and crushed down by the few, but which will dominate and rule the many, for without it the human race would cease to exist. Now, while it may be true that what we call the triumphs of civilization, the knowledge, the justice, the humanity, the right doing, of men are all that excuses the infinite wrong which members of our race have done each other, we must not forget that these rest on the animal in that race. If the race is to go on toward greater triumphs in the future, it must be by keeping the animal strong and healthy.

I emphasize this fact because there is at the present moment in this country a condition existing among the women which is cause for the gravest alarm. Let me briefly state facts as they are. An American girl, educated as is our pride to educate her, marries the man of her choice amid the warm good wishes of all her friends. She is clever, bright, beautiful, and looks forward to years of happiness and of usefulness. One or, at most, two children are born, and if we meet her we can scarcely recognize her. She looks dragged and worn, she is fretful and peevish, she is a confirmed invalid, doomed to suffer more or less during the coming years, and these, alas! may be many. Expressed in the fewest words, the evil is that an increasingly large proportion of the women of the American race are unable to perform their functions as mothers, and these women include the mentally best we have among us. The gravity of the evil confronting us lies in this, that we seem to be able to bring the women up to a certain point in mental development and then they cease to be able to be mothers. Why? It is to the last degree difficult to say why. The causes at work are very many, and while some are obvious others are merely suspected. It is not to be supposed for a second that all or even the majority of women who have been broken down have their own folly to thank for it, but while the number is relatively small, when compared to the number of the sick, it is the reluctant belief of those who have an opportunity of knowing "whereof they speak" that it is increasing. It is this belief which gives a part of its importance to the lowering of the birth rate in the United States, as shown by the census of 1890. The other and greater part of that importance is derived from the enormous number of cases in which the women have broken down as the result of a lack of stamina sufficient to meet the physical strain of child-bearing. It is, unfortunately, the fact that evidence of this evil is not confined to physicians. There is not a man or woman—and this is especially true of what we call the cultured classes—that does not count among his or her acquaintances married women who are confirmed invalids. The small average size of American families is a matter of notoriety. Let us see how this fact is reflected in statistics.

Massachusetts ranks deservedly high among her sister States in her patriotism, wealth, energy, industry, education and progress. The following figures of the births per one thousand population among her people during the years given are instructive:

1860	United States census	25·61
1870	" " "	22·63
1875	State census	20·60
1880	United States census	21·08
1885	State census	18·47
1890	United States census	19·22

Ordinarily speaking, the birth rate of a race is regulated by the food supply, and where there is an abundance of food the population increases in a ratio which may be easily ascertained. Now while I am willing to grant that the conditions of life in Massachusetts were easier in 1860 than they are now—that is, it was easier for a man to earn that which would enable him to buy sufficient food for his children—I do not think the difference in the conditions can correspond with that of the birth rate. If the opposite be alleged, we are required to believe in a deterioration of one quarter in these conditions during a period of thirty years, and that with the knowledge that were the agricultural methods of Belgium applied to the soil of Massachusetts, the amount of food produced would be two and one-third times what it is to-day. I submit this is a demonstration *ad absurdum*. Is it to be supposed that the conditions of life in Massachusetts are as severe as those in London, England? In the year 1883 the percentage of pauperism in London, of persons receiving indoor or outdoor relief, was 29·6 in the 1,000, while in Massachusetts it was less than 10. Yet the birth rate in London during the past eighteen years has remained nearly stationary, from 35 in 1875 to 33 in 1892. The birth rate of the whole of the United States has steadily fallen from 1880, running from 36 in the 1,000 of population in that year to 30 in 1890.—*Dr. Cyrus Edson, North American Review.*

THE MORAL EFFECTS OF PHYSICAL EXERCISE.

It is rather late in the day to undertake to demonstrate the advantages of physical exercise in the education of youth. The wholesome precepts of antiquity in regard to the necessity of not only developing the body as well as the mind, but of developing the body in order to insure a good development of the mind, were sneered at and slighted in the middle ages. From those ages came down almost to our times a notion that while it was well enough as a means of health to take bodily exercise, it was a matter of secondary importance and should be relegated to an inferior place in a course of education. That notion is no longer entertained in the leading civilized states. In fact, the pendulum of opinion has swung so far in favor of corporeal exercises that there seems some chance of its swinging the other way. In some countries, notably the United States and France, there are thinkers entitled to respect who seem inclined to take the position that too much time is now given in schools and colleges to outdoor games and sports, and that it would be well to take measures in the interest of sound learning and thorough mental education to abridge the hours devoted to trials of skill and open-air contests. Not sharing these opinions, we wish to point out one argument against them which seems to be too little considered.

Exercise, even violent, is not only good for the physical health, but also most excellent for the moral health. For there are moral qualities which reading and reflection do not develop, and these are the qualities which belong to the man of action—boldness, resistance to fatigue, coolness in the presence of difficulties and dangers.

In ancient times thinkers attributed to physical exercise a marked influence over the development of the moral faculties. Quite recently a gentleman who writes with ease and elegance, M. A. Magendie, has elucidated this point in a little book, worthy of the most careful attention. He demonstrates in turn the excellent results of physical exercises from the point of view of the development of the attention and that of perception of things exterior to the person. The child and youth are endowed with great aptitude for receiving impressions, that is, for perceiving things and instructing themselves. It is incontestable that games in the open air furnish varied and interesting means of exercising the superior senses. The mistakes made by any player are instantly perceived by his attentive comrades. Ordinarily, there is no need to call special attention to these mistakes; the awkward player himself recognizes them immediately, and almost at the instant discovers the way to avoid them thereafter.

From the point of view of interior perception, the effects of collective games are neither less sensible nor less favorable. The companionship and observation of his comrades enables the young scholar to study himself with more precision by giving him occasion to make a rapid analysis of his own thoughts. Thence arises the influence of physical exercise on the development of the memory and the imagination. Games in the open air cause an active circulation of the blood, which, constantly purified, imparts intense life to the whole organism. Under normal conditions this increase of physical energy increases the force and vivacity of the imagination, and as, under the influence of feeling thoroughly well, the youth who plays is disposed to take a cheerful view of everything, his imagination becomes not only vivid, but filled with gracious and smiling images. Moreover, games in company favor the birth of generous sentiments among all the players and develop among them sympathetic inclinations which are so closely allied to the imagination.

The case is the same in what concerns the judgment and the reasoning powers. By the force of things, each player observes attentively what is passing around him, in order to take, at the proper moment, steps useful for the game. The youth must take his resolution without an instant's delay, or his adversaries will derive profit from his hesitation. In the course of the game the youth always reasons closely; he observes too nearly what is passing to allow him to be at a loss when it is a question of recognizing and defending his own interests. Undoubtedly the reasoning of the players has not for its object the demonstration or the discovery of profound truths of any very high order; but, if the youth is obliged to reason in his games, and especially to reason justly, the importance of these exercises will be evident to every one.

It is hardly necessary to go further and point out how self-respect, emulation and, in a general manner, the sentiment of honor, are increased and fortified by the same means. The associations formed for collective games offer the advantage of uniting in the same groups youths of different and even opposite characters; of combining energetic players with companions disposed to be indolent and effeminate; of bringing together players of vivacity, of inconstant humor and comrades who are calm, patient and tenacious. By neutralizing in a word, the defects of some by contrary qualities in others, sociability and a feeling of the solidarity of humanity become more easy.—*Revue Internationale; Literary Digest.*

A VISIT TO THE HAVEMEYER & ELDER REFINERY, BROOKLYN.*

By Messrs. A. HERZFELD and W. BARTZ.

After the preliminary work previously described, the melted sugar is subjected to a preparatory clarification with a kind of superphosphate or with an extract of bone black treated with hydrochloric acid. Ordinarily raw sugar solutions of cane sugar have a slightly acid reaction, but where considerable beet sugar is mixed with it it may become entirely neutral or even alkaline. The degree of acidity throughout the process of work is not controlled in any regular way. By the application of the superphosphate herein named a precipitate is formed which is composed more especially of phosphate of iron and of alumina. The precipitate doubtless contains some silicates and some organic substances. When the low products of beet roots are melted they probably find phosphate of lime in these precipitates.

This precipitate exercises a mechanical clarification, and it is rendered more energetic by the addition of a little milk of lime, that is to say, a neutral phosphate of lime is formed. However, there is never sufficient milk of lime added to render the reaction alkaline, as is done in defecation in beet sugar houses, as such excess of lime would render the liquid dark by the action of the lime on the invert sugar.

The precipitate being sticky, sawdust is added to the liquid before filtration and it is filtered with Kroog presses with large plates.

The work of refining is carried on at a very low temperature, which we carefully avoid in Europe because we fear the formation of ferments that will induce inversion. It is believed that in working cane sugars, which are already infested with these ferments and contain invert sugar, it is necessary to energetically combat the development of these agents. On the other hand, it must be remembered that acid juices containing much invert sugar cannot be boiled at a high temperature without the abundant production of caramel. We must here also consider that in America molasses or sirup for consumption is sold advantageously, and sometimes even more advantageously than the solid produce.

As soon as the treatment with superphosphate is completed the juice is subjected to the antiseptic action of sulphurous acid. In order to avoid useless inversion the juice is held at a temperature within the limits of 50 to 60 deg. C. This low temperature has no inconveniences, and it seems even that there is a certain advantage in the reduction thereto. Thanks to the sulphurous acid, the juice, thus far very dark, receives a notable bleaching, which is not without importance.

The application of sulphurous acid is not controlled chemically at this stage of the work. And further, such control would be useless, owing to the great variation in quality of the sugar melted. The appearance and odor are sufficient to regulate the work of the sulphurous acid and are better guides than chemical tests.

After this the juice is filtered, always at the average temperature indicated above, on 70 per cent. bone black in fine grains. The revivification of the bone black is done by washing with warm water, and even in the filters. It is found useless to burn it and to treat it with hydrochloric acid to eliminate the carbonate of lime and the sulphate of lime. Each filter of the battery is treated individually, according to the character of the raw sugar melted, and the filters are washed ordinarily every 24 hours.

The filtered juice is then sent into the vacuum boiling apparatus, where a higher vacuum is used than is known in Germany. It corresponds to a temperature of 60 deg. C., or even as low as 50 deg. C., and under these conditions the boiling is completed. An effort is made to have a very large heating surface. The enormous vacuum pans are of cylindrical form and have been used since the first years of the decade 1880-90. They are furnished with the means for rapid emptying and have arrangements for boiling close, which in Germany have not attracted attention until recent years.

The coils are parallel and arranged vertically over each other, and the apparatus has large openings which permit the discharge of the strike in five minutes. This portion of the refinery interested us keenly.

By boiling at such low temperature the crystallization in the apparatus becomes more abundant, and

* Translated for *The Louisiana Planter* from *La Sucrerie Indigene.*

the delay of the masse cuite in the tanks to complete crystallization at a still lower temperature either with or without movement thus loses its importance. Further, as has been said in the preliminary observations, the obtaining of a maximum of sugar is not a chief desideratum as in Germany.

This fact justifies the manner of carrying on the subsequent operations, which are without precedent in respect to rapidity and simplicity.

In fact the masse cuite falls directly from the vacuum pans into a grand tank situated over the centrifugals. A vertical mixer there divides and distributes it. Over each centrifugal the tank or mixer has an opening, and the work of drying the sugars is begun within five to ten minutes after the boiling is completed. The mass falls directly from the vacuum pan into the mixer, and from the latter into the centrifugals, which are driven from below in such a way that the laborers stand on a platform and do not have to ascend or descend to work their machines. They do not use any wash in the machines when following the old method. Cold water is used with a kind of sprinkler. In the cases where granulated sugar is not produced, but loaves or cubes, the work is done much as in Germany. The apparatus, other than the Kroog filter presses, are all of American construction. The loaves of sugar, weighing about fifty pounds, receive no clarifying. The points are broken off and the rest is not sold in the shape of loaves, for there is no demand for such, but they are broken into pieces.

The pieces thus broken constitute here the sugar most sought for consumption. There is produced also directly from the masse cuite cube or pressed sugar by means of such machines as are also used in Germany. There is also produced by the refineries that use moulds, powdered sugar and sugar still finer, or as fine as flour.

The sirups of the sugar are used for food consumption after a new filtration through bone black.

MAHLER'S CALORIMETRIC SHELL.

INDUSTRIAL physics presents no problem more interesting than that of the determination of the calorific capacity of combustibles. Such determination is at present effected either by the Berthier process, which is inaccurate, or by means of elementary analysis, which is delicate and takes a long time to execute. Precise results are easily reached by the use of the calorimetric bomb of Messrs. Berthelot and Vieille. Unfortunately, this apparatus, employed by Mr. Berthelot at the College of France, is too high priced to suit the finances of industrial laboratories, on account of the large quantity of platinum that enters into its construction.

Mr. P. Mahler has devised a calorimetric shell which is a modification of the apparatus of the College of France, and which is the outcome of the following desire of his: To put into the hands of engineers a relatively cheap apparatus, a true coal tester, to permit them to easily test solid, liquid, and gaseous fuels with all the precision of a scientific process, which, although simple, is none the less very much improved.

This new apparatus has been tested in public at the Society of Encouragement, and in the laboratory of the School of Mines in the presence of a number of railway engineers, manufacturers, metallurgists, etc. The use of it has since spread throughout Europe, and has extended to America and Egypt.

Principle of the Apparatus.—The combustible is placed in a vessel with strong sides, into which oxygen is afterward introduced under pressure, and which is then hermetically closed. If the apparatus is then immersed in the water of a calorimeter, and the combustible is lighted by any artifice whatever, the latter, owing to the great quantity of oxygen, will burn completely and almost instantaneously. Its disengaged heat will be transmitted without any loss to the water of the calorimeter and to the various parts of the apparatus, and it will be easy to estimate it as in all calorimetric operations. Only, in the present case, seeing the rapidity of the experiment, the majority of the corrections in use in the cabinets of physics become negligible, for example, those due to the evaporation of water.

Description of the Apparatus.—Mr. Mahler's apparatus consists essentially of a shell, B, of a calorimeter, D, of an isolating jacket, A, and of an agitator, S. The shell is of soft steel or forged iron. It has a capacity of about 600 cubic centimeters, and its sides are 8 millimeters in thickness. Such capacity, which is much greater than that of the Berthelot calorimetric bomb, has the advantage of assuring in all cases a perfect combustion of the coal through a certain excess of oxygen, even when the purity of this gas as found in the market leaves something to be desired. Besides, the shell may thus serve for the study of the gases of industrial generators, which contain as much as 70 per cent. of inert matters, and of which it is necessary to take a large quantity if it is desired to determine an observable elevation of the temperature of the calorimeter.

The shell is nickel plated externally. Internally it is protected by a coating of enamel against the corrosive action of the nitric acid that always forms during combustion. This coating of enamel, necessary for the preservation of the apparatus, replaces the several thousand francs' worth of platinum that lines the apparatus of the College of France.

The shell is closed by means of a screw plug, which is tightened through a lead washer. The plug carries a cock with a screw having a hard steel point, and that serves for the introduction of the oxygen. It is traversed by a well insulated platinum electrode prolonged in the interior by a platinum rod, E. Another platinum rod likewise fitted to the screw plug supports the flat capsule, C, in which the combustible to be experimented with is placed. The latter is ignited by putting it in contact with a small spiral, F, of iron or platinum wire, that an electric current burns at the desired moment, and that thus plays the role of a primer.

The calorimeter, the isolating jacket, and the agitator differ in numerous details that decrease the cost as compared with that of the analogous parts of the apparatus in use in Mr. Berthelot's laboratory.

Mr. Berthelot's helicoidal agitator is here actuated by a very simple and easy-running kinematic combination that permits the operator to give the system a regular motion without fatigue.

Let us mention, too, the thermometers that indicate the fiftieths of a degree, the generator of electricity (magneto or bichromate battery) of 12 volts and 2 amperes, and a counter of minutes (watch or sand glass).

Mr. Mahler takes his oxygen from cylinders furnished by the Continental Oxygen Company. As the pressure proper for the combustion of 1 gramme of coal is 25 atmospheres at the most, and as the cylinder of the usual model contains 1,200 liters (120 atmospheres), there is therefore at hand a supply for a hundred experiments.

Determination of a Calorific Power with the Shell.—This operation is exceedingly simple. The following is the manner in which it is necessary to proceed in order to determine the calorific power of a solid or liquid combustible.

A gramme of the substance to be tested is weighed in the capsule, C, and the piece of wire, F (No. 28 or No. 30), of a known weight, that serves as a primer, is adjusted. After the whole has been introduced into the shell, the plug of the combustion chamber is screwed up tightly, and to this effect is seized between the jaws of a vise, E.

The cock of th · shell is then put in communication with the cylinder of oxygen, O. The cock of the latter being afterward opened with precaution, oxygen is allowed to enter the shell until the manometer marks 25 atmospheres. After the cock of the oxygen cylinder has been closed, the cock of the shell is also closed very accurately and the tube connecting the cylinder and shell is detached.

It is recommended that the substance be not weighed in too fine a powder, and that the oxygen be introduced slowly, so that the material in the capsule shall not be blown out by the current of gas.

The shell thus prepared is placed in the calorimeter, A. One arranges therein the thermometer, T, and the agitator, S, and then the water that has been previous gauged is poured in. The liquid is agitated for a few instants in order that the system as a whole shall put itself in an equilibrium of temperature, and then the observation is begun.

The temperature is noted from minute to minute for about five minutes so as to fix the law that the thermometer follows before the ignition. Then the ignition is effected by means of the electrodes of a battery or an electrical machine. One electrode is applied to the terminal corresponding to the platinum rod, E, and the other to any point whatever of the cock. The ignition occurs immediately.

The temperature is noted half a minute after the beginning of the minute in which the ignition is effected, and then at the end of the minute, and the thermometric observations are continued from minute to minute up to a point at the end of which the thermometer begins to fall regularly. This is the maximum.

The observation is continued for five minutes more, so as to fix the law followed by the thermometer after the maximum. We have then the principal elements of the calculation, and in particular of the sole calorimetric observation that it is proper to make under the circumstances of the operation. It is the correction due to the loss of heat that the calorimeter has undergone during the operation.

This correction is easily effected according to the following rule, which is true within very wide limits, even in case the equivalent in water of the system is only half that of the Mahler apparatus:

1. The law of the decrease of temperature observed after the maximum represents the loss of heat of the calorimeter before the maximum and for a minute considered, on condition that the mean temperature of such minute does not differ by more than one degree of the maximum temperature.

2. If the temperature of the period considered differs by more than one degree, but by less than two degrees of that of the maximum, the figure that represents the law of decrease at the moment of the maximum, diminished by 0·005, again gives the correction sought.

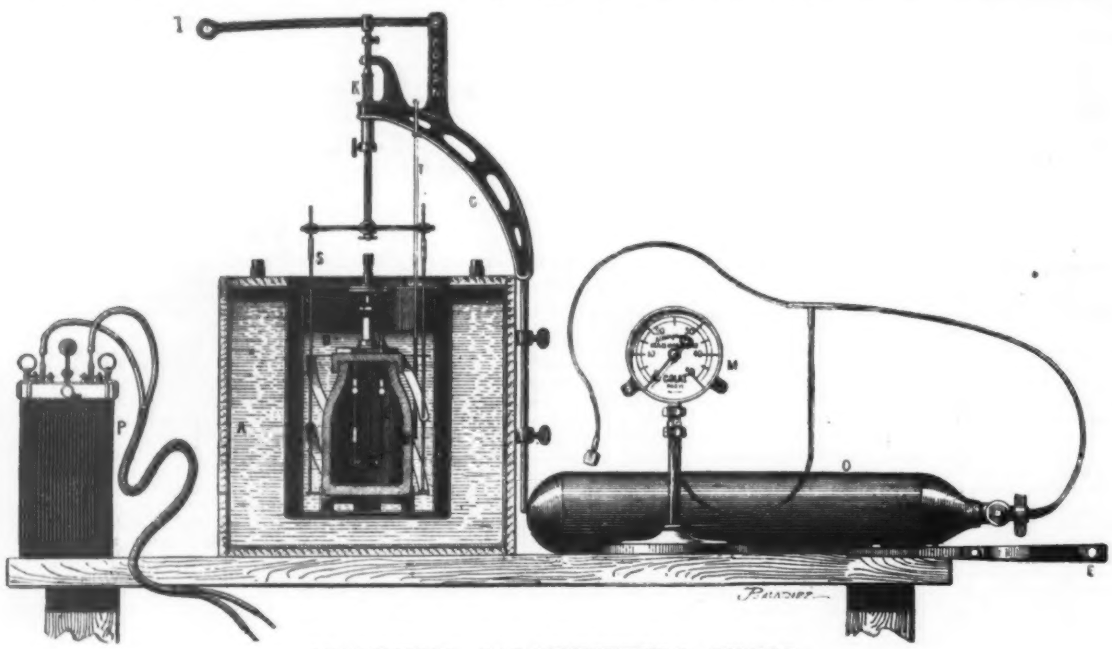
The two preceding remarks suffice in all cases. It will be admitted, moreover (and that, too, without altering the precision of the operation), that the law of variation followed during the first half of the minute in which ignition takes place is that which existed at the moment of the minimum.

During the entire duration of the observation, the experimenter must take care to make the agitator operate regularly. When the observation is finished, the cock of the shell is first opened, and then the shell itself. The interior of the shell is washed with a little water so as to reunite the acid liquid formed during the explosion. The nitric acid is estimated acidimetrically, and we then possess all the elements of calculation, since the calorific power, Q, is in sum: $Q = \Delta (P + P') - (0{\cdot}23\, p + 1{\cdot}6\, p')$, Δ being the difference of corrected temperature; P the weight of the water of the calorimeter; P' the equivalent in water of the shell and accessories; *p* the weight of the nitric acid (A_3O_5H) found; *p'* the weight of the iron spiral; 0·23 the heat of formation of one gramme of dilute nitric acid; and 1·6 the heat of formation of one gramme of iron. If it is a question of testing coal, one does not, in proceeding thus, take account of the quantity of sulphuric acid that results from the oxidation of the sulphur of the specimen and which is estimated like the nitric acid. The error is in fact negligible in an industrial experiment. But it will be remarked that as the sulphur is entirely oxidized and converted into sulphuric acid, the shell offers a means of estimating it, even in the case of lighting.

The process is the same for a liquid as for a solid. However, if the liquid emits sensible vapors, it is well to weigh the sample in a thin ampulla with tapering points through which passes the wire primer. At the instant the ampulla is introduced into the shell, care must be taken to break off its points in order to permit the oxygen to come into contact with the liquid.

Mr. Mahler has likewise determined the calorific power of various gases. The manipulation is easy: After a vacuum has been formed in the accurately gauged shell, it is filled for the first time with gas. A vacuum is formed a second time, and one introduces definitely the gas under barometric pressure and at the temperature of the laboratory. Oxygen is then added, and one proceeds as for solids and liquids. An improvement recently devised by Mr. Sainte-Claire Deville and adopted by the Parisian Gas Company permits of filling the shell through the circulation of the gas.

The determination of the calorific power of gases offers a peculiar difficulty: it is necessary to dilute the gas in such a quantity of oxygen that the mixture shall cease to be incombustible. For illuminating gas, 5



MAHLER'S CALORIMETRIC SHELL.

atmospheres of oxygen suffice. For the gas of industrial gas generators, a half atmosphere, measured by a mercurial manometer, should not be exceeded.

Determination of the Equivalent in Water of the System.—In order to determine the term of correction representing the exact equivalent, P', in water, of the system, the simplest method is to make the following experiment: A known weight, one gramme, for example, of a product of well fixed composition, say naphthalene, the heat of combustion of which is exactly known (9,692 heat units), is burned in the shell.

Results of Experiments.—The apparatus presented by Mr. Mahler to the Society of Encouragement at its session of November 27, and by Mr. Berthelot to the Academy of Sciences at its session of November 30, 1892, has already served to effect more than three hundred combustions. Its precision leaves noting to be desired.

Thus Mr. Mahler has, with his shell, found the heat of combustion of naphthalene to be:

1st	Experiment.............	9,680 heat units.
2d	"	9,690 "
3d	"	9,694 "

Now Mr. Berthelot admits 9,682 heat units, a figure that does not differ from those above.

In the appended table the author has brought together a certain number of results of experiments made with his apparatus in the laboratories of the School of Mines in order to determine the calorific powers of various combustibles.

This table gives the composition and calorific power of seven specimens of coals and of a series of liquid combustibles sent by the Messrs. Deutsch. We call attention particularly to the figures relating to the products of distillation of American petroleum in their works at Pantin. This table permits of comparing the calorific power of each combustible tested, observed directly with that which it would have exclusive of ashes and water. Among the labors of Mr. Mahler, those relative to the calorific rendering of the distillation of coal on a large scale are interesting. They show that, out of 100 heat units introduced into the retort under the form of coal, there have been found 96·5 heat units utilizable after distillation.

It results that a certain amount of heat has been lost during the distillation, but that the results of the industrial operation are in reality satisfactory from a calorimetric point of view.

Mr. Mahler has likewise drawn up a table of the calorific power at a constant volume (at 0° and at a pressure of 760 millimeters of mercury) of some gases resulting from the industrial distillation of coal. These gases he burned in his enameled shell, the capacity of which was 654 cubic meters, and with five atmospheres of oxygen. The differences found with the one hundredth of a degree thermometer, 1·3°, 1·31°, 1·477°, etc., show that it was capable of operating with precision.

We have stated above that the shell is capable also of serving for the determination of the calorific power of the gas of industrial generators, and that in this case we ought not to exceed a half atmosphere of oxygen. As an example of this important application of the calorimetric apparatus, we may mention the results of experiments made upon the furnace gases of a glass works.

The composition of these gases in volume was as follows:

Formogen..............................	2
Hydrogen..............................	12
Oxide of carbon........................	21
Carbonic acid	5
Nitrogen..............................	60
Total..........................	100

Whence may be deduced a certain calorific power.

On another hand, the shell has furnished 1,112 heat units as the calorific power of a cubic meter at 0° and under a pressure of 760 millimeters.

Now, it requires three times less time for the direct and exact determination by means of the calorimetric apparatus than for the indirect determination by means of a volumetric analysis made by processes that are rarely free from criticism.

Upon the whole, Mr. Mahler's calorimetric shell seems destined to render very great services in the industries, in all cases where there is an interest in knowing the calorific power of combustibles. It is simple and practical, and nevertheless gives results of great precision. With a little practice, it does not take half an hour on an average to perform a complete experiment and determine exactly the calorific power of a specimen. Besides, the cost of it is relatively low, especially if it is compared with that of the calorimetric apparatus of the College of France.

Mr. Mahler announces that some improvements in detail, in still further lowering the cost, will permit of the method being widely used.

A NEW SCLEROMETER.

THE new sclerometer represented herewith is the work of Mr. Paul Jannettaz. The process of measurement that he proposes and for which he has had various apparatus constructed, and which is founded upon the production of a scratch and also upon the determination of the latter by the microscope, has already been pointed out by Prof. Martens, director of the laboratory of applied mechanics of Charlottenburg. This process is employed by the German artillery.

The definition adopted by Mr. Jannettaz for hardness is, therefore, after the example of mineralogists, resistance to scratching.

The advantages of this process are quite numerous. Thanks to it, it is possible (1) to easily produce a scratch by hand, which gives a first approximation; (2) by means of a convenient apparatus always to place one's self under identical conditions and obtain regular and similar scratches; (3) on observing the scratches under the microscope, to measure their dimensions and especially their width, with any approximation that may be desired.

In principle the apparatus is reduced to a vertical point bearing, through any force whatever (say a weight or spring), upon the body to be examined, which must itself be exactly horizontal.

Mr. Jannettaz is at present studying a simple type of the apparatus. The one that he presented to the Academy of Sciences is quite complicated. In fact, this apparatus was made not only for determining the relative hardnesses of different bodies, but the variations of their hardness upon the same face of a crystal, which are very feeble and which, in order to be measured accurately, require special care.

Moreover, as we shall see from the description of this apparatus, certain details, without being indispensable, may be useful in the determination of the hardness of metals. It consists essentially of a platform rendered horizontal by means of leveling screws and provided with various organs of motion that permit of placing any region whatever of the body whose hardness it is desired to determine under a vertical point. This latter is carried by a scale beam, L, so that it can be rendered exactly perpendicular to the body that it is to scratch. The vertical motions of the beam are of two sorts—a rapid motion and a slow one, which brings the point into contact with the body without shock.

The beam is provided with two pans, Q and Q', designed to receive the weights that produce the pressure. In addition, at one of its extremities, on the side of the pan, Q', the beam carries a screw, which, according to the direction in which it is turned, increases or diminishes the length of the beam, and consequently permits of obtaining exact horizontality. At the other extremity of the beam, under the pan, Q, there is a hollow rod forming a tool carrier, which, through the pressure of a nut, is capable of receiving a whole set of points, P: (1) Copper or steel points of variable angle, rectilinear or recurved so as, once in place, to make determinate angles with the platform; (2) crystalline points set into a metallic jaw. The use of crystalline points is not only necessary for attacking very hard bodies, but has, moreover, the advantage of permitting one to have recourse to very approximate elements of hardness, as, for example, are the angles or the edges of a same crystal.

A is a hollow cylindrical balance formed of tubes sliding within one another by means of a rack and pinion, C. When the beam has been lowered, through the intermedium of the rack, until the point is very near to the body to be scratched, the collar, B, is tightened, and then, by means of a threaded button situated between the branches of the fork, F, and permitting of a slow motion without a shock, a perfect contact is obtained.

The arrangement that consists in thus fixing a point to a balance has the following advantages: (1) of producing an absolute verticality, which is shown by the indicating needle of the beam; and (2) of annuling the weight of the point, and consequently of permitting of acting with very feeble forces, such as decigrammes, while the point alone weighs several grammes.

The acting weight, I, is placed in the pan, Q. In order that it shall always be at the same point of the latter, that is to say, in order that the lever arm shall preserve a constant length, this weight is composed of disks, strung upon a vertical rod placed in the prolongation of the scratching point.

The body to be examined is brought beneath the point by a series of different movements, which, as a whole, are supported by four vertical columns. There is, in the first place, a horizontal frame whose two edges form slides for a plate, H, connected with a micrometer screw, M, which produces a to and fro motion of the plate.

To this latter is fixed a drum, T, containing a clockwork movement which is wound up by means of a key, O. In the center of the drum there is a vertical axle to which is fixed a disk with rollers, G, which roll over the drum when the clockwork is in operation.

In this way there is obtained a regular rotary motion occurring in a perfectly horizontal plane. The object of this rotation is to obtain a circular striation. This arrangement is especially indispensable in the study of the hardness of crystals, but may prove equally advantageous for metals. In fact, as the action is produced at all points in an identical manner, one is certain that every variation in the dimensions of the scratch is due to the body itself, and not to a difference either in the manner in which the contact of the point has taken place, or in the velocity of the relative displacement of the point and body.

A NEW SCLEROMETER.

Finally, upon afterward examining the scratch under the microscope, all causes of error are eliminated. The revolving disk, designed to obtain horizontality, contains three apertures into which enter the three leveling screws, S, of the support. This latter consists of two superposed horizontal plates, one of which is capable of becoming eccentric with respect to the other, through a screw, U. Moreover, four screws, V, traversing nuts fixed to this same support, S, serve to tighten the object carrier. All these motions permit of placing beneath the point such a part of the body as may be desired.

The bodies studied are either fixed to the stage or object carrier by springs, R, or are fastened upon it by means of resin or gum lac.

Some experiments made upon a series of specimens of steel from the Company of Forges of Chatillon and Commentry show that this method is capable of permitting of giving a sclerometric classification of metals. It is likewise capable of rendering defects in homogeneity evident. Considerable variations in the width of the striæ produced in electrolytic copper have thus been detected.

It will be seen, then, that the microscope, which has already permitted of so important micrometallographic studies, is destined to render engineers valuable services in the study of hardness.—*Annales Industrielles.*

COMPOSITION AND CALORIFIC POWER OF VARIOUS COMBUSTIBLES.

Designation of combustibles.	Elementary analysis.						Volatile matters, exclusive of water.	Elementary analysis, exclusive of ashes and water				Calorific power.	
	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Hygroscopic water.	Ashes.		Carbon.	Hydrogen.	Oxygen and sulphur.	Nitrogen.	Observed directly.	Exclusive of ashes and water
												Calories	Calories
Rough coal of the Sainte Marie mine..........	79·378	4·967	8·725	1·13	3·90	1·90	30·10	84·265	5·273	9·262	1·200	7,865·8	8,350·1
Commentry gas coal..............	80·182	5·245	7·193	0·98	3·00	3·40	37·40	85·664	5·604	7·682	1·050	7,870·4	8,408·5
Lens gas coal..............	83·727	5·216	6·007	1·00	1·05	3·00	29·55	87·261	5·436	6·263	1·040	8,305·0	8,744·7
Treuil smith coal..............	84·546	4·772	4·502	0·84	1·25	4·00	19·75	89·231	5·026	4·856	0·887	8,301·7	8,856·7
Saint Mark smith coal..............	88·473	4·139	3·158	1·18	1·35	1·70	13·65	91·256	4·269	3·255	1·220	8,302·5	8,656·5
Anthracite coal of Kebao..............	85·746	2·733	2·071	0·60	2·80	5·45	4·56	93·456	3·065	2·825	0·654	7,828·1	8,532·0
Anthracite coal of Pennsylvania	86·456	1·995	1·449	0·75	4·45	5·90	2·75	95·378	2·201	1·596	0·830	7,484·4	8,256·4
Coke of American petroleum..............	96·855	0·489	1·196	0·26	....	0·20	....	98·051	0·490	1·198	0·261	8,067·2	8,073·3
Heavy oil of American petroleum..............	86·894	13·107	....		....	....	....	86·894	13·107	....	....	10,912·7	10,912·7
Refined American petroleum..............	85·491	14·216	0·293		?	....	....	?	?	?	?	11,045·7	....
American naphthaline..............	80·583	15·101	4·316		?	....	....	?	?	?	?	11,086·0	?
Crude American petroleum	83·012	13·889	3·099		?	....	....	?	?	?	?	11,094·1	?
Heavy oil of Bakoo..............	86·700	12·944	....		....	0·35	....	87·005	12·989	....	....	10,804·6	10,842·6
Novorossisk petroleum..............	84·906	11·636	3·458		?	....	....	?	?	?	?	10,328·0	?

—*Revue Industrielle.*

PHYSICS AT THE BRITISH ASSOCIATION.*

SECTION A met in the well appointed lecture theater of the Nottingham University College. Mr. Glazebrook had only just finished his presidential address when an incident occurred which was of interest as showing that members meant business, and were not disposed to allow the authority of the chair to be questioned. Perhaps the experimental work communicated was not of striking novelty or importance, but some of the informal communications and discus-

* From *Nature.*

sions—notably those on electrical theory, the connection between ether and matter, and the teaching of elementary physics—were of great interest, especially to teachers of physics. This was largely due to the active part taken by Lord Rayleigh, Professors Fitzgerald, Carey Foster, Oliver Lodge, Rucker, and other leading physicists. The discussion occasionally tended to resolve itself into an exchange of ideas around the lecture table, but as the ideas were for the most part interesting (and energetically expressed), members did not appear to object. At first there was an occasional grumble against Dr. Lodge's innovation of starting at 10 A. M., but the wisdom of the change was shown by the fact that the section had generally to sit until 2 P. M.

At the first sitting on Thursday (September 14), after the president's address, the "Report of the Committee on Solar Radiation" was communicated. Observations have been made with a thermometer inclosed in a non-conducting case, an image of the sun being thrown upon the bulb. Simultaneous readings of screened thermometers within the case were also taken, and the excess of temperature noted from minute to minute. The thermometer has since been replaced by a thermo-junction, which works very sharply, the readings becoming steady in about six minutes, whereas with the thermometer twenty minutes are required. The readings were calibrated by comparison with an iron copper junction, heated in paraffin oil and balanced against the actinometer couple. 1° F. was found to be equal to about thirty-six divisions. Another committee gave detailed reports of magnetic work at the Falmouth Observatory. The other committees submitted formal reports asking for reappointment, in some cases with small grants of money.

Professor G. F. Fitzgerald gave an interesting communication on "The Period of Vibration of Disturbances of Electrification of the Earth." The period of oscillation of a simple sphere of the size of the earth, supposed charged with opposite charges of electricity at its ends, would be about $\frac{1}{17}$ of a second; but the hypothesis that the earth is a conducting body surrounded by a non-conductor is not in accordance with the fact. Probably the upper regions of our atmosphere are fairly good conductors. In a Geissler tube air is a good conductor, and we know that when part of a gas is transmitting an electrical disturbance the rest of the gas in its neighborhood becomes capable of transmitting such as well. Extending the analogy, we may assume that during a thunderstorm the air becomes capable of transmitting small disturbances. If the earth is surrounded by a conducting shell, its capacity may be regarded as that of two concentric spheres, and is accordingly greater than that of a simple sphere, which would produce a corresponding change in the rate of oscillation. But at the same time the presence of currents in the outer air would alter the self-induction: and calculation shows that the net result is a comparatively slight change in the period of oscillation. If we assume the height of the region of the aurora to be 60 miles or 100 kilometers, we get a period of oscillation of 0·1 second. Assuming it to be 6 miles (or 10 km.) the period becomes 0·3 second. On the sun we might expect very much greater periods of oscillation, but these oscillations would not give rise to radiations. If alternating currents of the kind referred to really traveled north and south around the earth they would give rise to east and west alternating magnetic forces of periods between $\frac{1}{10}$ and $\frac{3}{10}$ of a second. Dr. Lodge has already looked for evidence of such magnetic forces, but on the assumption that the period would be $\frac{1}{17}$ second. The author has calculated what magnetic disturbances would be produced by given charges. A disturbance equal to $\frac{1}{10}$ part of the horizontal force of the earth would correspond to an electrostatic charge of 80 C.G.S. units per sq. cm. Such a charge would reduce the superficial pressure on the earth by an amount corresponding to a weight of 40 gm. per sq. cm. This does not sound probable, but we must remember that it would correspond to a most fearful magnetic storm. A charge of 8 C.G.S. units per sq. cm. would produce a variation of $\frac{1}{100}$ of H, and would not sensibly affect the barometer. The records of existing magnetic observatories are not sufficiently complete to admit of testing the other suggestions made in the paper. Professor O. Lodge thought that the detection and observation of such magnetic disturbances was work that could only be done in a national physical laboratory. If the sun were a conducting body surrounded by a non-conductor, the period of an electrical oscillation upon it would be 6½ seconds. He had hung up in his laboratory a needle and watched it for hours, but the only disturbances observed were due to trains and traffic. He pointed out that the electric vibrations of a molecule, calculated from its size, were more rapid than those required to produce light. He suggested the addition of a jacket like that which Professor Fitzgerald assumed to exist around the earth; but would this produce radiation?

The Moon's Atmosphere and the Kinetic Theory of Gases.—Sir Robert Ball has suggested that the absence of any atmosphere investing the moon is a simple and necessary consequence of the kinetic theory of gases. Professor Liveing has applied this theory to interplanetary and interstellar space, with reference to the chemical constitution of planetary atmospheres. According to Sir Robert Ball, the mean molecular speed of oxygen and nitrogen is less than the speed with which a body would have to be projected in order to leave the moon without ever returning; but in the course of collisions between the molecules they frequently attain speeds sufficiently great to enable them to overcome the moon's attraction, and thus escape from the moon's atmosphere. On the other hand, the speed required to permanently leave the earth is one which "it would seem that the molecules of oxygen and nitrogen do not generally ever reach," and therefore the earth retains a copious atmosphere. Mr. G. H. Bryan, in reading his paper on this subject, stated that no statistical calculations had hitherto been made with the object of testing these questions; he was not aware until his paper had been printed that explanations based on the kinetic theory had been suggested as far back as 1878 by Mr. S. Tolver Preston and Mr. Johnstone Stoney. Mr. Bryan has applied the theory to investigate that effect of varying temperatures upon the relative densities of oxygen and hydrogen in a permanent distribution under various conditions; he has also calculated the average number of molecules of gas to every one whose speed is sufficiently great to overcome the attraction of given bodies in the solar system, and gives tables showing the results. Thus for oxygen at 0° C., rather over one molecule in every *three billion* is moving fast enough to fly off permanently from the moon, and only one in every $23 \times 10^{[illegible]}$ is moving fast enough to escape from the earth's atmosphere; while the sun's attraction, even at the distance of the earth, prevents more than one in every $2 \times 10^{[illegible]}$ from escaping. In the discussion which followed, Sir Robert Ball stated that the suggestions really did not originate with himself, but were familiar to him as having been discussed many years ago in a paper by Mr. Johnstone Stoney. Among celestial bodies the moon is unique in having no atmosphere. In the earth's atmosphere there is no free hydrogen. Stoney's theory accounts for these effects. On the other hand, in the case of big bodies like Sirius it is hydrogen, and essentially hydrogen alone, which forms their atmosphere.

Grinding and Polishing of Glass Surfaces.—Lord Rayleigh stated that he had been investigating the nature of these processes, and gave a most interesting description of the results. He first pointed out that the process of grinding with emery is not, as is commonly supposed, a scratching process. The normal effect is the production of isolated detached pits—not scratches. The glass gives way under the emery; at the same time the emery gives way under the glass and suffers abrasion. An image seen through glass which has been finely ground (but not yet polished) has perfect definition. And so when the sun is viewed through a cloud the image is sharp as long as there is an image; even when the cloud thickens, the edge appears to be sharp until we lose the image altogether. A glass lens finely ground gives very good definition, but there is great loss of light by irregular reflection. To obviate this the lens is polished, and examination under a microscope shows that in the process of polishing with pitch and rouge the polishing goes on entirely on the surface or plateau, the bottom of each pit being left untouched until the adjoining surface is entirely worked down to it. It appeared interesting to investigate the amount of glass removed during the process of polishing. This was done both by weighing and interference methods, and the amount removed was found to be surprisingly small. A sufficiently good polish was obtained when a thickness corresponding to 2·6 wave lengths of sodium light was removed, and the polishing was complete when a thickness corresponding to 4 wave lengths was removed. Lord Rayleigh is of opinion that the process of polishing is not continuous with that of grinding, but that it consists in a removal of molecular layers of the surface of the glass. Grinding is easy and rapid, whereas polishing is tedious and difficult. The action of hydrofluoric acid in dissolving glass was also investigated, and was found to be much more regular than it has generally been assumed to be by chemists. It was found to be easy to remove a layer corresponding in thickness to half a wave length of sodium light; and with due precautions as little as one-tenth of a wave length.

Mr. W. B. Croft exhibited simple apparatus for observing and photographing interference and diffraction phenomena. No bench was used, but the various pieces of apparatus were mounted on the usual stands used for holding lenses, etc. One of these contained a thin aluminum plate with a needle hole, or the slit of a spectroscope. On this the light of a lamp was focused by means of a lens. As an observing eyepiece, the eye-piece of a Beck microscope was used and was placed about 2 ft. from the slit or point, the object being introduced between. The stands should be adjusted so that the light proceeds straight into the eye-piece. The whole of the special apparatus required need only cost a few shillings, and with this the usual phenomena of Fresnel's bi-prism, sharp edges, perforated zinc, etc., can be both seen and photographed. Mr. Croft exhibited an admirable series of slides photographed direct with the aid of his apparatus, including interesting examples of the bright central spot in the shadow of a small opaque screen (shot).

On Sun Spots and Solar Envelopes.—The Rev. F. Howlett gave an account of observations and records made by him during the last thirty years of sun spots, etc., and stated that he had not on a single occasion been able to verify the assertions made in 1769 by Dr. Wilson with reference to the behavior (through foreshortening) of the umbra and penumbra as a sun spot approaches the limb of the sun.

On Friday a report was submitted "On our Present Knowledge of Electrolysis and Electro-Chemistry." This was part of a report which was being drawn up by Mr. W. N. Shaw and Mr. T. C. Fitzpatrick. Many investigators have been engaged upon electrolytic work, but their observations have been published in scattered papers and expressed in a manner which makes comparison of them difficult. The present installment of the report is the work of Mr. Fitzpatrick, who has at great pains collected all the available information on the electro-chemical properties of solutions in water and has compiled an exhaustive table showing the different chemical salts in solution. Data are given respecting conductivity, temperature coefficients, migration constants of ions (from which one can calculate the rate at which ions travel through solutions), fluidity (the inverse of viscosity), etc. As with falling objects, so it is with ions; they travel more quickly through a limpid fluid than through a viscous one. This is just why acids conduct better than salts.

On the Connection Between the Ether and Matter.—Professor O. Lodge made a further report as to experiments made with the same apparatus as that which he had described to the section at the Cardiff meeting in 1891. Ever since Fresnel's time the question has been debated whether (1) the earth carries with it the ether in its immediate neighborhood, thus causing a disturbance, or (2) rushes through it, and it through the earth, each being independent and moving independently. Dr. Lodge has been endeavoring to settle this question by finding out whether a rapidly revolving steel disk (like a circular saw) exercises any drag upon the ether in its immediate neighborhood. He uses two such disks of tough steel, about a yard in diameter, rotating in parallel planes an inch apart. He is now able to run the disks at the rate of 3,000 revolutions per minute; but even at this high speed no effect is observed which can be attributed to any drag of the ether. He has also replaced the disks by an oblate spheroid of wrought iron with a deep channel or groove cut in it and wound with wire; but the rotation of this transversely magnetized mass (weighing about a ton) does not set the ether in motion.

A Mechanical Analogue of Anomalous Dispersion.—Mr. Glazebrook described a mechanical model which he had constructed to illustrate the theory of anomalous dispersion propounded by Sellmeyer, and developed by Helmholtz and Lord Kelvin. The model consisted of rows of balls connected to each other by elastic strings and connected to fixed beams by springs of varying stiffness.

Professor Fitzgerald communicated a note on Professor Ebert's method of estimating the radiating power of an atom, and stated that the results show that molecules have a complex structure, otherwise they would radiate very badly. Professor Fitzgerald holds that the vibration of an atom is the mechanical vibration of a minute bit of the corresponding matter; and that the ionic charges by their corresponding vibrations excite the external radiation.

Lord Rayleigh gave the results of his investigations on the "Theory of Reflection from Corrugated Surfaces," and also, in the absence of the author (Lord Kelvin), read two papers "On the Piezo-Electric Property of Quartz," and "On a Piezo-Electric Pile." These were followed by two interesting communications on electro-magnetic work carried out under the direction of Professor Hertz in Bonn.

On Electric Interference Phenomena.—Mr. E. H. Barton described experiments on phenomena somewhat similar to Newton's rings, but exhibited by electromagnetic waves in wires. The waves were generated by a Hertzian primary oscillator consisting of two disks of 40 cm. diam. each connected by a wire 1 m. long to small brass balls between which sparks passed. Opposite these disks, and about 30 cm. distant, were two similar ones, from which proceeded a pair of parallel copper wires 8 cm. apart and 160 m. long. Along these the waves were propagated and the interference phenomena exhibited. The phenomena in question were produced by hanging sheets of tinfoil on the wires for a certain part of their length. Where the sheets hung the capacity and self-induction of the leads were changed, thus causing a partial reflection of the waves from the *beginning* of this *abnormal* part. But a *second* reflection occurs at the *end* of this part also. Thus interference phenomena were set up, and as the length of the abnormal part was gradually increased the intensity of the transmitted waves was found to periodically increase and diminish. Mr. Barton has recently given (Proc. Roy. Soc.) a theory of these phenomena with which the experiments are in fairly good accord.

On the Passage of Electric Waves through Layers of Electrolyte.—The method and apparatus used in this research were described by Mr. G. H. Yule in a communication to the Royal Society in June last, and an experimental curve was given in the same paper showing that the transmission of trains of electromagnetic waves through a layer of distilled water follows the same law as that of light through a thin plate, *i. e.*, that the transmitted intensity varies periodically as the thickness of the plate increases. Similar curves were now given, using dilute solutions of zinc sulphate, alcohol, and a mixture of alcohol and water; in all cases the periodic character of the curve was very well marked. As the transmitted intensity attains its first maximum when the thickness of the layer is half a wave length, the method may be used to determine dielectric constants. That found for water was 69·5, and for 95 per cent. alcohol 26·7—values agreeing roughly with the high values found by previous investigators.

Mr. J. Larmor referred to a familiar type of caustic curve, produced by reflection from a strip of metal bent into circular form. He pointed out that the source of light need not lie in the plane on which the caustic is thrown—the caustic preserves the same form whether the incidence is direct or indirect.

On Saturday the following papers (mainly of mathematical interest) were communicated: "On a Spherical Vortex," by Professor M. J. M. Hill; "Note on the Magnetic Shielding of Two Concentric Spherical Shells," by Professor Rucker; "The Effect of a Long Tube as a Magnetic Screen," and "The Effect of a Hertzian Oscillation on Points in its Neighborhood," by Professor Fitzgerald; "The Magnetic Action of Light," by Mr. J. Larmor (Dr. Lodge characterized this as being perhaps the most suggestive communication made during the meeting, and expressed the hope that it would be further developed and printed); "A Special Class of Generating Functions in the Theory of Numbers," by Major MacMahon; "On Agreeable Numbers," by Lieutenant-Colonel Cunningham.

On Monday Mr. Horace Darwin exhibited and described the instruments used by the Committee on Earth Tremors. Professor Milne presented the report of the committee on the volcanic and seismological phenomena of Japan, and gave a most interesting account of the work done by himself and other observers in Japan.

Instruction in Physics.—The greater part of the sitting was taken up by a discussion on the teaching of elementary physics. This was introduced by Professor Carey Foster, who exhibited and described some simple and cheap apparatus for teaching practical physics. The apparatus shown was well adapted for elementary class work in heat and electricity. Mr. W. B. Croft followed with a paper in which he described the plan of science teaching at Winchester School, where, by an order of the Privy Council, science is compulsory for almost all the boys. The aim is to arrange for that which may be imposed on all as part of a good education—to supplement thought with the observing faculty. The scheme is also suited for those who may hope to become mathematical physicists and who should in boyhood devote themselves mainly to mathematics. For some boys, science forms the best foundation of early education. Public schools are not generally adapted for these cases; but they can well be provided for by a liberal elasticity of system. Professor O. Lodge read a paper in which Mr. A. E. Hawkins gave the results of his experience of science teaching in public schools, especially in Bedford School.

He deprecated the influence of examinations on the teacher's work. Dr. Gladstone considered that apparatus should be not only cheap but simple. To use complicated apparatus was almost as dangerous as to depend upon blackboard work. He agreed with Mr. Buckmaster that too much work was usually expected from a science master. Mr. D. E. Jones emphasized the last point, and stated that instances had come under his notice where science masters had no time to prepare their experiments for class. The idea that science, unlike other subjects, ought to pay for itself, was much to be deprecated; it should not be neglected or abandoned in a school merely because it was costly. The teaching of physics as an educational instrument had not been sufficiently developed; and Continental schools were not much in advance of English ones in this matter. Mr. Jones gave an account of the system of teaching experimental physics as now carried out under Mr. Rintoul at Clifton School. Referring to the subsidizing of science teaching in secondary schools, he pointed out that supervision of some kind must accompany public aid. If the evil effects of examinations were to be avoided, an efficient system of public inspection must be developed, and the inspectors should be men with experience of teaching work. Professor Fitzgerald agreed with this; and Dr. Lodge expressed his regret that head masters of schools could not be compelled to attend and listen to discussions such as this. The president, in concluding the discussion, said that an effort should be made to replace examinations by an intelligent system of inspection.

Electrical Standards.—The last sitting was held on Tuesday, Sept. 19. The president, as secretary, submitted the report of the Electrical Standards Committee. This report defines the unit ohm as being the resistance of a column of mercury 106·3 cm. long, and of 14·4521 grammes mass at 0° C. The B. A. unit is equal to 0·9866 of the ohm thus defined. The French authorities had forwarded through M. Mascart four names, which were proposed for the ohm of the 106·3 cm., and of these names the committee on the whole preferred "international." The resolutions respecting the electrical units passed at the Edinburgh meeting have now been accepted in Germany, France, Austria, Italy, and the United States, and throughout the British empire. Professor Carey Foster said it should be known that the work of the committee was really the work of the president (Mr. Glazebrook).

On Standards of Low Electrical Resistance.—Principal J. Viriamu Jones described the method of determining the ohm devised by Lorenz and used by Lord Rayleigh and subsequently by himself. The method consists in rapidly rotating a copper disk coaxially in the mean plane of a standard coil, the same current being led through the coil and through the low resistance which is to be measured. By varying the speed of rotation the difference of potential between the center and the circumference of the disk can be made to counterbalance the difference of potential at the ends of the resistance. Professor Jones pointed out that it is not only the most accurate method of measuring the ohm, but that it is especially suited for the measurement and production of very low resistances. Errors are necessarily produced in stepping down from a standard ohm, say by the potentiometer method, to a resistance of 1-1,000 or 1-10,000 of an ohm. The Lorenz method is sufficiently simple and accurate to be adapted for the direct production of low resistances from a rotating disk and standard coil without going through the circuitous process of stepping up to a standard ohm and down again. The difficulty of making a good contact with the edge of the disk is avoided by using a tube with mercury running through it at constant pressure. Difficulties were encountered in using the electrically-driven tuning fork; for, although it vibrated uniformly when once started, it was liable to a small change when stopped and started again. A series of experiments on a resistance of 1-2,000 of an ohm was given in which the variation from the mean of the extreme values was only 1 in 12,000. Lord Rayleigh expressed his pleasure at the extraordinary accuracy now obtained by the method. In his own experiments, the electrically-driven tuning fork, instead of being stopped and started again, was kept on all day, and compared at the beginning with a free fork of the same frequency (128). In a recent paper Dorn has criticised the various methods used in the determination of the ohm, and has raised against Lorenz's method the objection that particles of iron in the disk might affect the result by altering the permeability inside the coil. This assumes that the presence of such particles would introduce a direct factor into the result, which would only be true if the whole space inside the coil were so filled.

Apparatus for Comparing Nearly Equal Resistances.—Mr. F. H. Nalder exhibited a modified Wheatstone bridge for comparing nearly equal resistances. In applying the Carey Foster method only a small portion of the usual meter bridge is brought into actual use, and in Mr. Nalder's modification only the part thus used (about 1 decim. long) is provided. This can be replaced by other wires of the same length but of different diameters and, therefore, resistances; of course, the resistance per unit length in each of these is known. The comparison coils are wound in a single bobbin, so as to avoid temperature errors; these, and errors due to the thermo-electric effects, are materially reduced by the compactness of the whole apparatus. Dr. O. Lodge described a new form of galvanometer for physiological purposes. It was designed by himself and made by Messrs. Nalder Brothers. The nerve currents excited by stimuli are exceedingly feeble and, even with the so-called non-polarizable electrodes, the currents under investigation are frequently masked by other effects. Physiologists require an exceedingly sensitive ballistic galvanometer; but they appear generally to use needles which are far too heavy, and galvanometers which are too highly damped, and which manifestly cannot be so delicate as undamped galvanometers. The best form of galvanometer for their requirements is one which contains a very light needle built up of short pieces of highly magnetized steel wire, and in which the coils are small and are wound up as close as possible to the needles. The instrument exhibited had four such coils and four needles, forming an astatic system suspended by a quartz fiber in a very weak field. Compared with the usual galvanometers of the same resistance, its sensitiveness was at least twice as great. Professor Boys has shown that excellent definition can be obtained from a small scrap of reflecting mirror; and Lord Rayleigh has shown that a pointer read by a microscope admits of just the same degree of delicacy as the mirror method. As biologists are accustomed to looking through microscopes, Dr. Lodge suggested that they might prefer to observe through a micrometer eyepiece a needle with a bee sting as pointer. Professor Fitzgerald suggested that the damping might be further reduced by hanging up the needle in a vacuous tube; and that the polarizations might be swept out by introducing capacities as in cable work.

A Simple Interference Experiment.—There is a well-known interference arrangement in which the object glass of a telescope is covered by an opaque diaphragm containing two narrow slits. An observer looking through the telescope at a radiant point or slit parallel to the two narrow slits sees a bright central band of white light bordered by interference bands. Lord Rayleigh had investigated the part played by the telescope in this arrangement, and found that the interference bands can be equally well obtained by using a plain brass or cardboard tube, having at one end a single slit and at the other a double slit consisting of two fine scratches on a piece of chemically silvered glass about 1-100 of an inch apart. The president thanked Lord Rayleigh for introducing such a simple form of interference experiment, and said it should be more generally recognized that, inasmuch as the eye contains a lens and screen, we can frequently do without an observing telescope in optical experiments.

On Specula for Reflecting Telescopes.—Dr. A. Shafarik communicated the results of investigations which he has carried on since 1870 with the object of producing specula having greater tenacity than that of the Ross telescope. Silvered-glass mirrors produced by the Foucault method suffer rapid deterioration in the air of large towns. The addition of phosphorus is found to make bronzes harder and closer; and the addition of iron, nickel, or cobalt gives them a surprising degree of tenacity. In general, the strongest alloys are those which contain the metals in atomistic proportions; and even a small deviation from this proportion appears to diminish the strength considerably. The process of grinding specula differs from that of grinding glass, for alloys are never homogeneous. They are full of crystals, as can be shown by partially dissolving out with acids. The relative tenacity of the Rosse speculum and of two other alloys is given below:

$R = Cu_4Sn_1$	Strength	= 1·00
$ZN = Cu_8Sn_1Ni$	"	= 6·33
$D = Cu_4Sn_1$ + 4 per cent. Zn	"	= 0·52

Several members pointed out that what was really required was a knowledge of the values of Young's modulus for the various alloys investigated, and that it was doubtful whether this was what the author referred to as "strength," or in what way the measurements had been carried out.

The Ether.—Professor O. Lodge communicated a supplementary note on the ether. He had been asked how could dust polarize light if there was no mechanical connection between ether and matter? But on the electro-magnetic theory there was no difficulty, for light is not an ethereal oscillation but an electrical oscillation, and if the dust has different values of μ and κ from the ether, it may affect the wave. Mr. Trouton stated that dust particles act as reflecting resonators with free periods. The president had to confess that he did not fully understand the sense in which Professor Lodge used the word "mechanical," but considered that a modified mechanical theory (*e. g.*, that of the quasi-labile ether) could explain all optical phenomena save those of electro-optics.

A discussion on "The Publication of Scientific Papers" was introduced by the reading of Mr. A. B. Basset's paper. Mr. Basset thinks it highly improbable that scientific societies of position and standing would consent to sink their individuality in order that arrangements might be made for the publication of all important papers in a central organ. The only feasible scheme seems to be the publication of a digest of papers by the co-operation of the various scientific societies; and if thought desirable, papers published in foreign countries might also be included. The development of a well known periodical is an easier matter than the starting of a new one; and as many authors already send abstracts of their papers to *Nature*, it might be worth while considering whether an arrangement could not be made with the proprietors of *Nature* by which a supplemental number could be issued (say quarterly) containing a digest of the most important papers published during that period. Mr. J. Swinburne characterized the present system of publishing physical papers as being about as bad as it could be. Papers should be printed and circulated beforehand so as to leave time at meetings for useful discussions. He thought the Physical Society was the most hopeful body to look to, and advised the sending of all physical papers to it. Professor Fitzgerald agreed with Mr. Swinburne that the publication of titles or indexes alone was unsatisfactory; it was like giving a stone to a man who asked for bread. Abstracts were better, for they gave a little bread with the stone, and he advised the translation of Wiedemann's *Beiblatter* into English. The *Philosophical Magazine* was the personal property of Dr. Francis, and even in the interest of science it was unreasonable to try to evict a man from his own property. The discussion was continued by Professor Rucker, Professor Carey Foster and Lord Rayleigh; and the president in summing up said that the general opinion appeared to be that the matter should be considered by a committee of the Royal Society, if possible in conjunction with the Physical Society.

A new form of air-pump by Professor J. J. Thompson was exhibited, in which two objects had been aimed at: (1) to use sulphuric acid instead of mercury; (2) to make the pump self-acting and automatic.

Oil Bubbles.—Mr. F. T. Trouton made a communication on a peculiar motion assumed by oil bubbles in ascending tubes containing caustic solutions. A long glass tube was exhibited containing a bubble (about three inches long) of sweet oil in a very dilute solution of caustic potash. On inverting the tube the bubble begins to rise, and waves develop on its surface like the knots on a bamboo. These are unstable, and presently resolve into spiral waves which are more stable, because they leave spaces along which the solution can stream past the bubble. If the tube is inclined instead of inverted the bubble crawls up with a slow, caterpillar-like motion.

Dr. R. H. Mill gave a most interesting account of the relation between the temperatures of sea water and air in the Clyde sea area, and illustrated his remarks by an excellent series of slides. After a somewhat unintelligible communication by Mr. E. Major, "On the disturbance of a fluid consisting of hard particles by a moving body, with special reference to the ether," the meeting closed with a hearty vote of thanks to the president.

THE CHLORIDE ELECTRICAL STORAGE BATTERY.*

By HERBERT LLOYD, F.C.S.

THE electrical accumulator which I will try to describe is known as the chloride cell. It is so called because the plates constituting the element are made up of tablets cast from fused chlorides of lead and zinc, held together by a frame or rim of antimonious lead. When these composite plates are cast, however, they are not capable of use in a storage battery. They do not contain material which is in any sense active material, nor material capable of becoming active in a secondary battery fluid. They are not capable of serving as oxygen plates, as they will not absorb oxygen, nor are they capable of use as hydrogen plates, as not only would their immersion in the dilute sulphuric acid of the storage battery result in contaminating the fluid with chloride of zinc, which would be fatal to its proper action as a storage battery fluid, but the effect of the hydrogen liberated would be to form hydrochloric acid, with the chlorine of the chloride of lead, which hydrochloric acid would further contaminate the fluid and make it inoperative as a storage battery fluid. Moreover, these tablets are non-conductors of electricity. It is plain, therefore, that a plate consisting of tablets of chloride of lead and chloride of zinc is worthless as a storage battery plate, and cannot be used as such. Its chemical composition must first be radically changed to fit it for use either as an oxygen plate or a hydrogen plate.

This chemical change is brought about by means of a bath of chloride of zinc or some equivalent substance, in which the plate of tablets is to be immersed in connection with a slab of metallic zinc. This arrangement is, in fact, a primary battery, in which the zinc acts as the positive element, while the tablets constitute the negative element.

This operation may be performed with current produced by a dynamo, but it is a very tedious and expensive process as compared with reduction by means of zinc.

The electro-chemical action in this combination results in withdrawing the chloride of zinc from the tablets by simple solution in the bath, and the withdrawal of the chlorine of the chloride of lead from the tablets and fixing it in combination with the zinc with the formation of chloride of zinc. It may, therefore, be said that the chloride of lead tablets constitute material which is destined to become active by electrical disintegration, which is brought about when they are connected with the zinc plates in the bath of chloride of zinc.

When this process of electrical disintegration is complete, and the chloride of zinc is washed out of the plate, a mass of crystallized metallic lead is left, which is suitable for immediate use in a storage battery, without the tedious forming process of Plante and without the application of any active material or material about to become active by the processes of Brush and Faure.

To describe in detail the process used in the manufacture of this plate, as it is carried on commercially, I will begin with metallic lead. The first step in the production of chloride of lead is to bring the lead into such a state of subdivision as to make it readily soluble in nitric acid. The old way of doing this was to pour molten lead into water and so granulate it, but a process which is more satisfactory is to melt the pigs of lead in a suitable furnace, and when the lead is brought to a high state of fusion to convey it through a pipe into closed chamber where it is delivered in a fine stream into a jet of dry steam, the result being that the lead is blown into a moderately fine powder and falls on the floor of the chamber. [Sample shown.]

This powder is then shoveled into earthenware baskets suspended in large tanks of dilute nitric acid. When the lead has gone into solution in the form of nitrate of lead, the clear nitrate of lead solution is run off into precipitating tanks, where, on the addition of hydrochloric acid, the chloride of lead is thrown down in a fine white powder, nitric acid being set free. This nitric acid is returned to the dissolving pots to be used there again in bringing fresh lead into solution. The precipitated chloride is then washed by decantation and thoroughly dried.

The next step is to mix the chloride of lead so produced with the proper proportion of chloride of zinc, when both are melted together.

The fused chlorides are next cast into tablets [samples shown] of any desired size or shape, and with a beveled or V-shaped edge as shown. These tablets are then placed in a second mould, called a framing mould, where they are placed at a fixed distance apart to allow the frame of antimonious lead to be cast around them. In this operation the result most desirable to obtain is to produce this framing lead in as dense a form as possible, so that, unlike the material destined to become active, it will not be attacked by the oxidizing current when set up in a cell. The ordinary method of casting storage battery grids is, of course, to pour the molten lead into the mould from an ordinary ladle. We have improved upon this method by forcing the molten alloy around the tablets under heavy pressure, with the result of not only forming a dense metallic frame, but also of making a very perfect contact between the pastille and the frame. The pastille, at the same time, on account of its peculiar form is dovetailed as it were into the frame. This form obviates the trouble so

* Read at the meeting of the Electrical Section, Franklin Institute, Philadelphia, Pa., September 26, 1893.

noticeable with the ordinary red lead plate, in which the grid is dovetailed into the plug; that is, the surface of the plug on each side of the plate is of a larger area than the center of the plug, so that the tendency is for the plug to split in the center and fall out on either side.

When the completed plate is taken from the framing mould it is placed in the reducing tank in connection with a plate of zinc, as described in the first instance. This reduction process extends over a period varying from twelve to twenty-four hours, according to circumstances.

When reduction is complete, the plate is thoroughly washed in running water. In order to be sure that the very least trace of chlorine has been removed from the plate, all plates are set up as cathodes in a bath of dilute sulphuric acid, plain lead plates being used as permanent anodes in this tank, and a heavy current is passed through the plates for several hours. If the reduction has been incomplete, the chlorine will make itself felt in this operation. Excepting through carelessness on the part of the workmen, it is practically impossible for the plate to contain any chlorine at this stage.

When the plates are removed from the hydrogen bath they are next set up in forming tanks in connection with the plain lead permanent negatives, and here they are charged continuously for several weeks, or until the crystalline, spongy lead has been completely converted into peroxide of lead. The theoretical amount of current necessary to form a pound of peroxide of lead is about 200 ampere hours, and owing to the beautifully porous structure of the plate this figure holds out very well in practice; the plates will always be found thoroughly peroxidized after they have received a little over the theoretical quantity of current necessary.

The positive plates after formation are then set up with the requisite number of negative plates (the active material of which is in a soft, spongy state as it came from the reducing tank), the lugs or terminals of the plates of each series being burned together with a hydrogen flame, after being insulated in the manner shown in the sample. The cells are then charged and discharged a few times until they give their proper capacity, when they are ready for shipment.

Chloride of zinc is used in this plate for two reasons. In the first place, it is impossible to cast plates of chloride of lead without it, as the casting, on cooling, falls to pieces, so the admixture of chloride of zinc is absolutely necessary on that account. In the next place, it will be readily seen that by the use of chloride of zinc it is possible to so control the density of the plate as to produce any porosity that may be desired, and as within certain limits the capacity of a plate is proportional to the porosity, this use of chloride of zinc is of vast importance.

In the manufacture of the ordinary red lead or pasted plate, the density of the material depends mainly upon the energy which the boy uses in pushing the red lead into the grid, and consequently the plates are seldom or never uniform. In the chloride cell, provided the materials are properly weighed and the mixture thoroughly stirred after fusion, the plates are essentially uniform, as the mixed chlorides become perfectly fluid and every plate cast is exactly like every other plate. It is never necessary to reject any plate for want of capacity.

The mixed chlorides on cooling crystallize into a hard, stony substance of a peculiar crystalline nature. After reduction the metallic lead is left in the form of fine acicular crystals, running through the plate perpendicular to its surface, and the elimination of the chlorine and the chloride of zinc provides minute cell spaces around these crystals, so that an immense surface is offered for the absorption of oxygen in the forming process.

Having arrived at the proper amount of chloride of zinc to use, there is no danger of buckling or warping of the plates from undue expansion, as this expansion can be accurately provided for in the tablets.

The capacity of cells of this type is from five to six ampere hours per pound of plate. The capacity for weight could be materially increased, but at the loss of durability.

At a discharge rate equal to one-half an ampere for each pound of plate, which is a higher rate than is recommended for any other lead element, this capacity of between five and six ampere hours per pound can be obtained. At this rate of discharge the efficiency of the cell will be very high, the loss in current being less than ten per cent. and the watt-hour efficiency from seventy-five to eighty-five per cent.

Diagrams obtained from discharge of the chloride cell on a street car on Lehigh avenue, in this city, show the variable loads to which storage batteries are subjected in traction work. The discharge current ran as high as 200 amperes for a cell weighing less than 40 pounds; in the second, over the same road, the current did not pass 100 amperes. One hundred and four cells in series.

We have diagrams of a discharge obtained from a battery of 96 cells of the type here shown, on the road of the Metropolitan Company, Washington, D. C. The load in this case was, perhaps, less than average, the tracks at the same time being in fairly good condition. The trip was about 12 miles, and several 5½ per cent. grades were encountered and over 50 curves.

A more recent curve, taken after the cells had been in use five months, shows an improvement over this one in voltage.

An examination of the complete element will show the special care that has been given to the insulation of the plates. It is well known that the liability of a storage battery to short-circuit has been one of the main causes of trouble. To overcome this we envelop the positive plate in a piece of beautifully woven asbestos cloth. Between this positive so protected and the negative plate we place a perforated grooved board of insulating material, the perforations in this board being made opposite t e pieces of active material in both plates, leaving free circulation of the electrolyte between the plates, at the same time keeping the asbestos cloth pressed against the face of the positive plate, causing it to form a tight covering over the face of the active material, and while making the plate absolutely safe from short circuit, it also adds very wonderfully to the life of the cell, since the peroxide is held in position where it can perform useful work instead of being deposited on the bottom of the cell. The channels in the board provide for the free circulation of the electrolyte and also allow for the escape of the gases. In traction work this form of insulation is found very beneficial, as the cell is vastly more durable than anything that has been before produced, and at the same time there is no unnecessary liquid to be spilled over the car.

It may be of interest to state that the company manufacturing this type of cell in France has supplied batteries for nearly two years to the North Paris Tramway Company, who operate two or three roads with battery cars, about 40 cars in all, I believe. I was on these cars about a year ago and they certainly were doing good work. The cars are about 22 feet long and have seats on the roof, having seating room for 54 passengers.

The Paris factory has for some years turned out over five tons of plates a day. They equipped the Popp stations in Paris with these accumulators some three years ago, which have been in constant use ever since. There are 24 sub-stations all charged in series, the lighting being done entirely from the batteries, there being two sets in each station, one being discharged while the other one is charged. There are in the neighborhood of 100,000 lamps run daily from these cells, the result obtained being very satisfactory, since in addition to the benefit derived from the batteries as a store, they also act as transformers, as the batteries are charged in a 3,000 volt circuit, each station turning out current to its immediate vicinity at 110 volts. The plates in some of these cells weigh 100 pounds each, the complete cell weighing over a ton and discharging at a rate of from 1,000 to 2,000 amperes each.

A company has recently been formed in England for manufacturing these cells, which has just completed works near Manchester, capable of a very large output. That company is controlled by Messrs. Mather & Platt, probably the largest electrical engineers in Great Britain, and the business is to be managed by Dr. Hopkinson. Under such management there can be very little doubt about the success of the business.

The demand for storage batteries in Europe is very great. European manufacturing companies, therefore, are not compelled to educate the public into their use.

A NEW METHOD OF ELECTRIC CULTURE.

THE new process of electro culture devised by Brother Paulin has been studied by its inventor in experiments scientifically conducted and verified, and its efficacy, as we shall see, is supported by sufficient proofs to attract attention. Brother Paulin has been occupying himself with electric culture for a long time, but after making himself certain of the favorable influence of electricity upon vegetation, how many experiments, tentatives and modifications of detail have been necessary in order to allow him to pass from theory to practice and determine the best method of utilizing the fluid? This is why the first serious experiments date back to two years only.

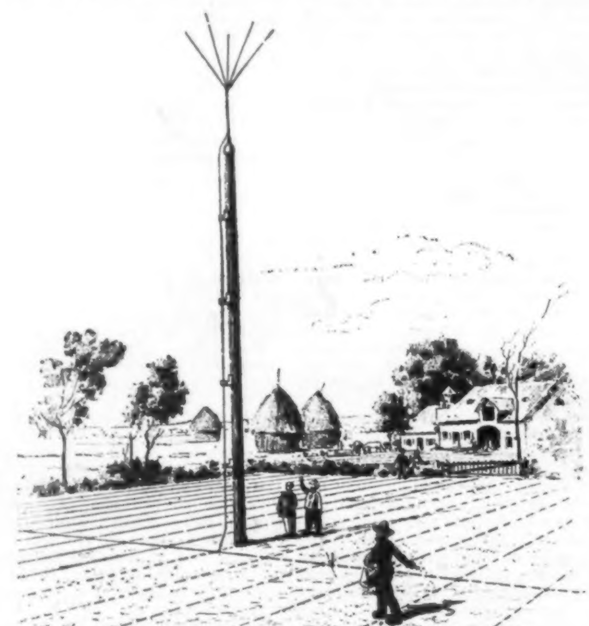
Through an apparatus of his invention, the "geomagnetifer," he collects and afterward distributes through the soil the electricity which, as a consequence of meteorological phenomena (storms, rain, wind, etc.), exists naturally in the atmosphere at a slight distance from the earth. The geomagnetifer consists of a resinous pole as high as possible (generally 40 or 60 ft.), which is planted in the earth, and, through the intermedium of porcelain insulators, supports a galvanized iron rod terminating in five branches of copper. This collector of electricity communicates through an iron wire with a system of other wires which, spaced 6 feet apart, distribute the fecundating fluid throughout the whole extent of the arable soil to be influenced. Such extent varies according to the height of the pole, 30 ares, for example, for a 50 ft. pole.

In the accompanying engraving the conducting wires are figured upon the surface of the earth in order to well show their arrangement. In reality they are buried to such a depth as not to interfere with the work of culture. Of course, such an installation lasts for several years. The apparatus operates as long as the wires have not been entirely destroyed by rust and still permit of the passage of the electric current.

Brother Paulin's first experiment in electro culture was made in 1891 in a potato field belonging to a cultivator in the vicinity of Montbrison. In the month of July a visit announced by the newspapers was made, and a report on the subject stated the following results: "The eye is arrested by a perceptible irregularity in the vegetation of the field. Within a circle limited exactly by the place occupied in the earth by the conducting wires of atmospheric electricity, the potato plants possess a vigor double that of the plants occupying the rest of the earth, and that, too, without a gap, without a feeble point in this group of superb stalks, sharply circumscribed as if by a line drawn by compasses."

The following is the report of the commission which, delegated by the Montbrison Society of Agriculture, decreed Brother Paulin a silver gilt medal: "A geomagnetifer 28 ft. in height made its influence felt over a superficies of 65 ft. radius. In this part of the ground the potato stalks, of extraordinary size and vegetation, have, up to this day (23d of September), preserved a verdure which perceptibly contrasts with the neighboring portions. These stalks were measured and were found to reach a height of 5 ft. and a diameter of ¾ in.

"After this first examination of the external vegetation, the members of the commission marked out upon this portion of the influenced field two quadrilaterals each of 52 ft. superficies, and then, in the rest of the earth, two squares of the same area. These two squares were laid out without a special selection of a place denoting a more vigorous vegetation, but responding to a mean either of the influenced part of the field or of the other part.



THE GEOMAGNETIFER.

"The 104 ft. of superficies of the influenced portion furnished 198 pounds of tubers. The 104 ft. of the non-influenced portion furnished 134 pounds."

The production per acre would, consequently, be 30,800 pounds in the part influenced, instead of 20,570. This product, obtained without special manuring, with a variety of feeble rendering (ordinary violet potato), equals the crops of intensive culture at a large expense for chemical fertilizers.

On October 11 the difference was still more pronounced, 60 ft. influenced furnishing 138 pounds, and 60 ft. uninfluenced only 83 pounds.

The second experiment took place in a vineyard. The report states that the maturity of the grapes was much more advanced and much more regular in the circle influenced than anywhere else. The juice of the grapes, chosen very ripe, gave with the must gauge and the alcoholometer the following results: The influenced must, sugar 16°, 20 per cent., alcohol 10·4; uninfluenced must, sugar 14, alcohol 9·1.

The following are some of the results of the succeeding year (1892): In the close of the brothers of the Christian schools (Novitiate of Vals near Le Puy), a 78 ft. geomagnetifer was installed in the month of April upon a field of spinach sown the preceding year. As early as the first days of May a manifest difference could be remarked in the vigor of the plants, and which was perfectly limited by a straight line corresponding to the conducting wires of the electric fluid. On May 14, upon a surface of 18 ft. in each part, the spinach pulled up with the root and weighed gave in the influenced part 53½ pounds, and in the uninfluenced 42 pounds, say a difference of 2·9 pounds per square yard. On May 21, the difference reached was 3 pounds per square yard, and on the 27th it was found by a committee of agriculturists, professors, etc., that the action of the atmospheric electricity brought about by the geomagnetifer was shown by a difference of product reaching 4 pounds per square yard.

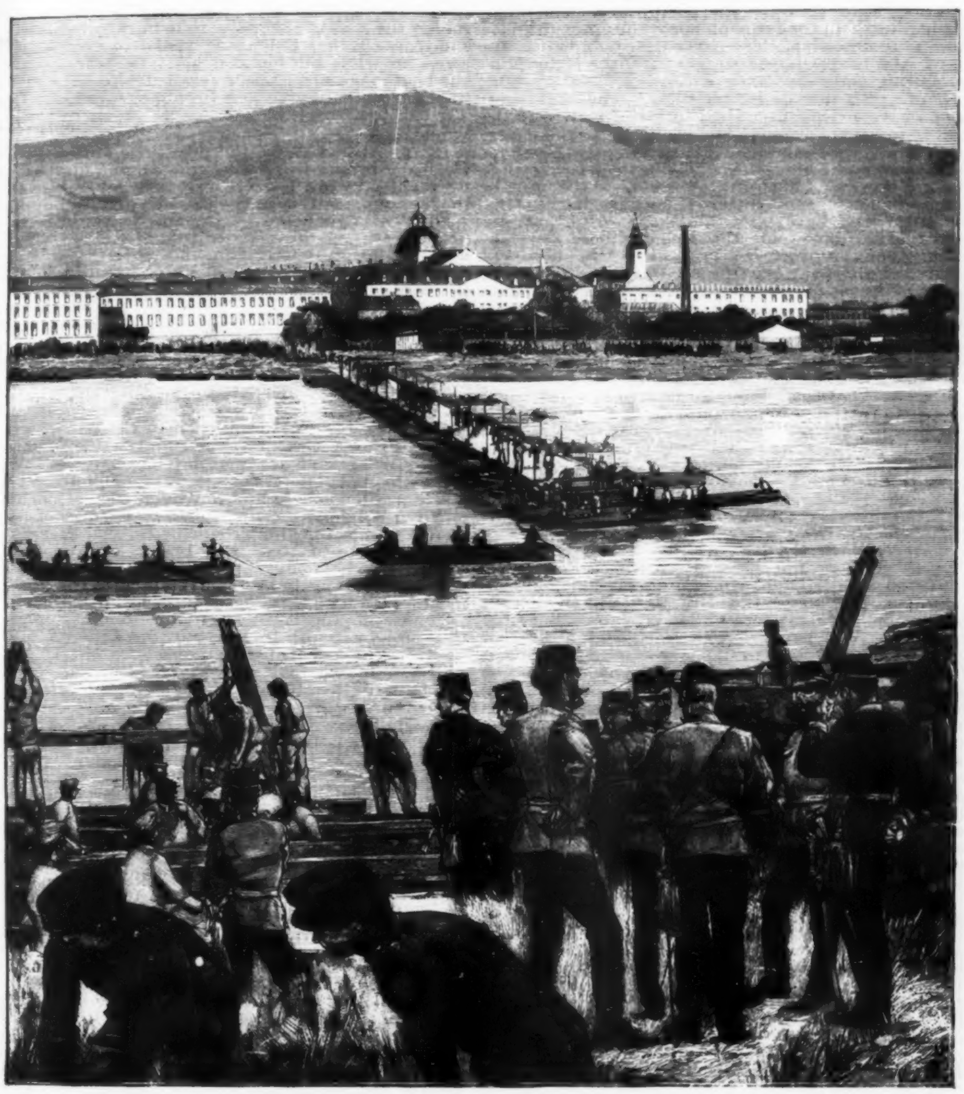
At Thueyts (Ardeche) spinach was obtained whose leaves reached a length of 1¼ ft. and celery of 3 ft.; at

Tours potato stalks of 8 ft.; in the Haute-Loire superb radishes and turnips; and at Orchies, in the north, sugar beets of the greatest richness.

In what manner does electricity behave to produce so remarkable results? Is there a decomposition of air and fixation of nitrogen in the earth, or does the fluid act simply by rendering more rapidly and perfectly assimilable the useful materials contained in the soil and manure? These are so many problems to be solved.—*L'Illustration.*

THE AUSTRO-HUNGARIAN MANEUVERS—CONSTRUCTION OF THE GREAT BRIDGE ACROSS THE DANUBE.

Two battalions of pioneers, No. 2, stationed in Linz, and No. 6, stationed in Krems, were ordered to construct a bridge near Krems. In building bridges, a detachment of troops is generally sent over the river, whose duty it is to clear the ground on the other side, and to hold it so that the construction of the bridge can be carried on undisturbed. The work then proceeds either successively, that is, one support is built after another, and one field after another; or in sections, parts of the bridge consisting of one or two fields having been prepared previously. In either case the bridge can be built from one bank toward the other, or from both banks toward the middle. Where circumstances will permit the latter method is employed, for in this way the bridge can be completed in a much shorter time.



THE AUSTRO-HUNGARIAN MANEUVERS—CONSTRUCTION OF A BRIDGE OVER THE DANUBE, NEAR KREMS.

The successive method of construction is used when there is very little time for preparation; and the section system when there is plenty of time and it is desired to surprise the enemy.

Our engraving, drawn by W. Gause, for which we are indebted to our excellent contemporary, the *Illustrirte Zeitung*, shows a light war bridge being built by the successive system over the Danube, near Krems, operations being carried on from both banks toward the middle of the stream. The river is here 1,133 ft. wide and from 6 ft. to 15 ft. deep, the water flowing at a rate of 8 ft. per second. Both banks slope, and the right one is about 14 ft. high, the left bank being about 12 ft.

As the normal height of the floating supports was less than 3 ft. above the surface of the water, it was necessary to arrange inclined approaches at both ends. Our cut represents soldiers building such an approach on the bank nearest the reader, while a large portion of the bridge has already been built out from the opposite bank.

Under the circumstances described, and with a force of 6 officers, 30 under-officers and 280 men, two hours were required for the construction of the bridge.

TRANSMISSION OF POWER.*

By R. S. ALLAN.

THE transmission of power is a subject of the utmost importance to the engineer, as I may say his reputation chiefly depends upon the results obtained by his mechanical contrivances. In these days when competition between manufacturers is so keen, and the prices accordingly so much cut down, economical machinery is essential, so that it becomes the chief aim of the engineer to design his motors and transporters with the greatest possible working efficiency. The transmission of power may conveniently be divided into two primary classes, viz.:

1. Short distance transmission.
2. Long distance transmission.

Various methods are adopted in each case, as are thought most efficient and economical under the working conditions.

Short Distance Transmission may be obtained by the following means: (1) Direct driving from motor shaft; (2) friction gearing; (3) toothed gearing; (4) screw gearing. Direct driving consists in prolonging the main shaft of motor, and obtaining the necessary power from it without the use of countershafting or gearing. The most common adoption of this method is in the marine engine, where the power transmitted is sometimes enormous, the most notable examples being the twin Cunarders Campania and Lucania, each of whose shafts will transmit no less than 15,000 i. h. p. when running at about 80 revolutions per minute. Such a shaft would be about 24 in. in diameter.

Friction Gearing is those forms in which the power is transmitted solely by the adhesion or reluctance of the driving agent to slip. The various devices in use at the present day are belting, ropes, and friction wheels. Driving by belting consists in straining flat belts, or bands, over cylindrical pulleys, or drums, which are keyed on the shafts to be actuated. Various substances are used for belting, such as leather, waterproofed cotton, rubber, and canvas, woven hair, etc., according to the class of machinery under operation. Leather is the substance most frequently used, and when properly tanned and stretched is the most durable, especially when running between setters for intermittent motion, as in workshops; the edges of belts made from other materials fraying much sooner under this action. Leather is generally used as a flat belt of varying width and thickness, according to the power required, and to prevent slipping off runs on a slightly rounded pulley.

Messrs. Tullis, of Glasgow, have introduced what is known as the chain belt, consisting of short links of leather connected in rows by wire pins passing through each series. This belt is very flexible, easily shortened, and the makers claim that when it is concaved to suit the convexity of the pulley it can transmit twenty-five per cent. more power than an ordinary flat belt of the same width. I think that this belt would be specially suited for high speeds, as the air current generated and drawn in by centrifugal force between the belt and pulley would readily escape between the links. This centrifugal action can be counteracted with ordinary belting by boring holes at short intervals, but this, of course, is at the strength of the belt. Messrs. Tullis have also introduced the narrow belts with V-projections riveted on the lower side, and working under the same conditions as ropes, to be described further on. Leather belts have been made up to 75 in. in width, Messrs. Sampson, of Manchester, having recently placed a belt of this width to transmit about 700 i. h. p. for a woolen manufacturing firm near Brussels. The composition belts are preferable to leather under some circumstances, as, *e. g.*, in damp places waterproofed cotton or vulcanized India rubber would be employed. Cotton has a breaking strength of about 4,500 lb. per square inch of section, while leather and rubber give way at about 3,000 lb., but the working tension is usually far below this, or from 300 lb. to 650 lb. per square inch of section.

Friction Wheels are sometimes used where a quick disconnection is desired, and where the power to be transmitted is small and no great uniformity required. The wheels are generally of the plain cylinder or wedge types. In the former, the working surfaces may be iron, but a coating of wood or leather greatly increases the adhesion. In the latter type, the working surfaces are V-grooves with an angle of about 30 degrees, turned true from solid cast. This style lessens the wear by increasing the working surfaces.

Rope Gearing.—This form of drive is now becoming extensively used in place of leather belting, especially for main drives. The ropes are made of hemp or cotton, the latter material being the most economical. They are circular in section, consisting of three or four strands sometimes twisted round a soft central core, thus giving the rope flexibility and preventing undue hardness. The main drive with rope gearing is taken from a large pulley keyed on the shaft, and having V-grooves truly turned on its circumference. The grooves have their sides inclined to include 45 degrees, and are shaped so that the ropes do not bottom, but are wedged in, the adhesive force being chiefly derived from the weight of the ropes themselves. The breaking strength of hemp varies from 9,000 lb. to 12,000 lb. per square inch of section, while cotton is about half of this. The power transmitted depends on the speed and tension, which are generally about 200 lb. to 350 lb. for cotton, and up to 900 lb. per square inch for hemp, with a velocity of from 3,00 ft. to 6,000 ft. per minute. The size of ropes in practice range up to 2¼ in. in diameter. Each rope requires a groove for itself, and as many as seventy ropes have been run from one pulley, transmitting about 4,000 h. p. Several drives at different elevations would be taken from such a pulley, and several ropes used for each drive. In addition to hemp and cotton, ropes made of leather, of square and spirally twisted sections, are sometimes used for light transmissions, the groove for the former being shaped about 70 degrees. Some makers profess to cast the grooves smooth enough for working, but they cannot be too smooth, and are better turned, those sizes below ⅞ in. being generally cut from the solid cast. For the smaller sizes of pulleys, the grooves when cast in may be made tolerably smooth by means of a rapidly-revolving emery disk introduced into groove as it slowly revolves in the lathe.

Toothed Gearing.—When the power to be transmitted is large, and where a constant or relative speed is required, friction rollers would slip, and to overcome this defect projections are cast on the face of the driving wheel working into interstices on the follower; and this constitutes what is termed toothed gearing. The form of this projection, or tooth, as it is called, should be such as to give the same uniform smooth motion as with plain rollers. The curves which are found to fulfill these conditions best are the involute and the epicycloid, and in practice these have been adopted. The involute is most suitable for some classes of machinery in which the pitch circles of the gear do not always coincide, as in crushing and rolling plant; but the epicycloid is almost universally adopted in general engineering. The exact contour or curves of the tooth is obtained by rolling a circle, the diameter of which is generally from one and one-half to three times the pitch, on the pitch circle of wheel or pinion. This gives an epicycloidal curve for the point of the tooth, and a hypocycloidal for the flank, when the wheel and pinion work externally, but when internally the curves of the wheel are reversed, the hypocycloidal becoming the point, and the epicycloidal the flank. The rolling-circle method has the disadvantage that only a wheel and pinion specially made for each other will work together. This objection can be overcome by using the odontograph invented by Willis, when all teeth, if of the same pitch, will work harmoniously. The teeth of gear wheels when first introduced were cut by hand; later on this gave place to casting from a full-sized pattern. These wooden patterns, owing to shrinkage induced by repeated contact with the damp mould, sometimes become distorted, and uneven teeth is the result, gear so produced tending to knock. A marked improvement on this method was the introduction of the moulding machine, which by gear wheels can divide the wheel circle into the exact number of parts there are teeth. For this method only the pattern for one tooth and a core box for one arm is required, or, better still, a set of arms if a suitable pattern can be found among the stock. All teeth moulded from the above methods, however, require a good amount of clearance, which is very objectionable and detrimental to gearing liable to sudden shocks. Modern science and improvement, however, has resulted in the wheel rim being cast solid, and teeth cut by milling tools turned to the exact shape of tooth section. Teeth made in this way are very accurate, and, to all appearance, approach as near as possible to perfection. They can be run at a high speed, and, having no clearance, are strong, and the whole face is insured of contact, thus distributing

* This paper is the prize essay of the Aberdeen Mechanical Society. The length of essay was restricted to what could be read in fifteen minutes.—*Elec. Engineer, London.*

the driving force; and these are results and advantages which cannot be obtained with any great degree of accuracy in moulded teeth. The various forms of wheels are spur, bevel, mortise, and helical. Spur wheels are used to connect two shafts running parallel. Bevels are the frusta of cones, the apices of which would meet in the intersection of the shaft center lines. When of the same size they are called "miter wheels." Bevels generally run at right angle, but when at any other they are called "skew bevels." Mortise or cog wheels are employed when the machinery is liable to shock, and where a quick, smooth motion is desired. They consist of wooden teeth, generally of hornbeam or beech, driven into rectangular holes cored in wheel rim, and are fixed at the back by iron pins and wooden wedges. Helical wheels have their teeth inclined generally at 55 degrees across the face of rim. The teeth are just part of a screw generated on surface of rim, and they may either be single or double helical. The former is sometimes objectionable on account of end thrust, but this defect is entirely overcome by the double helical, which, when cast with all their teeth intersecting in the center line plane, give a very steady motion each side of the tooth supporting the other. Helical is the strongest form of tooth we have, being about twenty per cent. stronger than the ordinary spur, while mortise is about twenty-five per cent. weaker. Other forms of toothed gearing are in use, such as sprocket and pocket wheels. Sprocket wheels and chains are used where a relative speed is required at a distance too great for wheel contact. The teeth are set radially on the rim of wheel, and work into pitched chains, which are now made up to large sizes. The links in the larger sizes are made of cast steel or malleable cast iron, while the smaller sizes are made from mild steel. These chains are largely used in elevating and conveying machinery, as the links form a ready means of attaching buckets and pushboards. Pocket wheels are generally made to suit the common forms of linked chains, the spaces for the links being hollowed out on the wheel rim, giving the name pocket. This style is chiefly used in hoisting machinery.

Screw Gearing is only used for secondary motions, such as in machine tools, etc. The screw threads usually employed for this purpose are either square or buttress, and work in conjunction with their nuts, transmitting the power by end pressure. The best example of the screw is for propelling steamships, the nut in this case being the fluid water. The endless screw and worm is another application, and, although most wasteful of power, is found very convenient in cases where the driving is wanted non-reciprocal, as when the inclination of the thread exceeds a certain amount the worm alone can act as the driving agent. The best example of these devices that I know of in Aberdeen is at the shearpoles, where the worm and wheel are used for the hoisting motion, the screw and nut for the derricking.

Long Distance Transmission is now chiefly employed in connection with the centralization of power—*i. e.*, in places where a great amount of power is required spread over a large area. It is found better to generate the power at a central station, and transmit it in quantities to suit the consumers, thus obviating the necessity of each small consumer having a generating plant of his own. The methods in use at the present time are: 1. Water under pressure. 2. Wire ropes. 3. Compressed air. 4. Electricity.

Water Under Pressure.—When water can be stored at a high level it possesses latent power by virtue of its weight, this potential energy being proportional to its height. This method was first introduced by Armstrong on the quays at Newcastle, where the head was obtained by pumping the water into tanks high enough to give the working pressure. When higher pressures came into use the height of those tanks became inconveniently great, and this led to Armstrong bringing out his hydraulic accumulator, the adoption of which marked a new era in hydraulic transmission, and to which this system owes its success. The hydraulic accumulator is the opposite of the hydraulic press, and consists of a cast steel or iron cylinder fitted with a ram kept tight by leather packing, and loaded to give the requisite pressure per square inch. A steam engine is employed to pump the water into the cylinder against this weight, the ram rising as the quantity of water increases. The rise and fall of the accumulator are automatically regulated by tappet arrangements connected either to the engine throttle or to a relief valve discharging back the overflow to the storage tank. The high pressure water is conveyed from the accumulator by a main, from which branches lead to all the motors. This system is almost exclusively English, and is adopted in some of our largest cities, such as London, Liverpool, Birmingham, etc. The machinery actuated is chiefly of the non-rotary class, such as hoists, cranes, bridges, etc.; but when a rotary motion is desired a hydraulic engine or water-wheel may be introduced. The usual pressure in these towns is about 750 lb. per square inch, at which pressure the available energy of one gallon of water is rather more than half horse power.

Wire Ropes.—This system is carried out on much the same principles as the rope drive. It is perhaps seen to best advantage on the Continent, where it was introduced by Hirn, and where it is extensively used, especially so in France. The ropes used are made of steel or iron, the former material being stronger and not so liable to stretch as iron. This tendency to stretch may, however, be lessened by passing the ropes through compression rollers previous to placing them in position. Ropes for transmission are of special make, being circular in section, and generally consisting of six strands of seven wires each, wound on a central core. A more flexible rope is made consisting of six strands of 19 wires each, both wires and strands inclosing a hempen core. The former class of rope is made up to 1½ in. diameter, the latter up to 2¾ in., and sometimes of a special quality of steel wire, having a tensile strength of 175,000 lb. per square inch of section. The size of pulleys for wire ropes should be as large as possible to prevent undue bending, and in practice they are about 3 ft. for a ⅜ in. rope, up to 22 ft. for a 1½ in. rope. Wire rope pulleys differ from the cotton rope style principally in the form of groove, the sides of which are usually inclined to include an angle of about 60 deg. or more, and are dovetailed in section at the bottom for the reception of lagging to preserve the rope and increase the adhesion. Various linings have been tried, such as India rubber, wood, cork, tarred oakum, and leather. Tarred oakum wound in the groove is very good, but leather has been found by experience to be the best. It is cut to the shape of groove section, and placed edge up through an opening in the side of rim of pulley, a closing piece of India rubber being used. This lagging is said to last on an average of about three years. The breaking strength of iron rope is about 90,000 lb. and steel about 120,000 lb. per square inch of section, but the working tension is about 25,000 lb. per square inch of section, when running at speeds up to 6,000 ft. per minute. When the distance of transmission is great the rope is run on supporting pulleys placed at short intervals, or relays may be used where the rope, instead of running all the way, only runs from one station to the other, a double-grooved pulley being thus required in the intermediate stations.

Compressed Air.—Ordinary atmospheric air approaching very nearly to the requisites of a perfect gas, is compressible, and this property has been taken advantage of by engineers to form a means for long distance transmission of power. This is accomplished by means of the compressor, which is just a piston pump fitted with inlet and outlet valves of special design. The air is drawn in during the in-stroke and forced during the out-stroke through the outlet valves either into a receiver, or reservoir, or directly to the motors. The heat developed during compression in the compressor is got rid of in three ways: by cooling the air before compression, water jacketing the compressor, or by introducing water in the form of spray into the cylinder during compression. The pressures in practice are from 50 lb. to 120 lb. per square inch, the latter pressure being generally got by means of the stage compressor, with intermediate cooling. The high pressure air is conveyed from the generating station to the motors by means of pipes laid similarly to those used in hydraulic installations. Paris and Birmingham have compressed air systems, but in the latter town it has not been a decided success, owing to the form of joint adopted, a large leakage taking place in the main. In Paris they have been more successful, and by adopting a rubber joint they have reduced the leakage to about 1⅛ cubic feet per mile per hour—a very small loss indeed when the quantity of air passing through the pipe is considered. Hydraulic shock limits the speed of water in the mains to about 3 ft. or 4 ft. per second, but with compressed air a speed of 50 ft. can be used with impunity. The greatest feats of engineering performed with compressed air have been the boring of the Mont Cenis and St. Gothard tunnels.

Electrical Transmission.—Power may be transmitted to a distance by converting energy in the form of mechanical work into energy in the form of the electric current. This is now generally performed by means of the dynamo-electric machine, which, to put it plainly, is just a machine for moving magnets past wires, or *vice versa*, the connections being so arranged that the E.M.F.'s produced may generate currents. This is accomplished by fixing magnets round about (not on) an armature, which is a drum or ring carrying the conductors in which the current is developed and thence imparted to the circuit by means of collectors, or commutators. For a long time electricity was thought fit for nothing but the controllation of signals, but since the advent of dynamo-electric machinery, a different aspect has been given to the system, and it now bids fair to revolutionize the world. The chief application as yet made of electricity is for lighting purposes. In this case the current is conveyed by means of insulated copper wires, two of which are required to complete the circuit, the difference of potential between the wires giving the flow, the pressure of which is measured in volts, and the rate of passage in amperes. An important and increasing application of electricity is on the electric railway, where the current is supplied by means of a feeding conductor of special channel iron laid and supported on insulators between the rails. A passing connection is made between the conductor and the electric motor, which is generally fixed direct on the axle shaft, by this means saving intermediate gearing. Electricity is also coming to the front as a transmissive agent in connection with the utilization of waste water power by the turbine. The best system yet completed on this basis is between Lauffen and Frankfort, a distance of 108 miles. The power is got from a turbine at Lauffen gearing into a dynamo, and the current is conveyed to Frankfort by means of three copper wires supported on oil insulators, which are carried on poles similar to those used in the telegraph. The efficiency of this system is said to be over 70 per cent., as out of 130 horse power generated at Lauffen no less than 80 is delivered to the motors at Frankfort—truly a wonderful result. An installation far beyond anything hitherto attempted is at present being completed at Niagara Falls, in America, where facilities for generating and transmitting 450,000 horse power are being fitted up, and representing a value in motive power of no less than 2½ millions per annum.

WHO INVENTED THE SCREW PROPELLER?

A VERY interesting article appears in the *Stevens Indicator* for April, and is reprinted in pamphlet form and distributed by the Hoboken Ferry Co., under the title of "The First Steam Screw Propeller Boats to Navigate the Waters of Any Country." It is written by Mr. Francis B. Stevens. The purpose of the article is to set forth the claims made for Col. John Stevens to the invention and first application of the screw propeller and to describe certain of his designs exhibited at the World's Fair, by the Hoboken Ferry Co. It is summarized in *The Railroad Gazette* as follows:

In 1791 Colonel Stevens took out a patent for a method of propelling a steamboat by the reaction of water and another for a multitubular steam boiler. In 1798 he was engaged with Chancellor Livingston, Nicholas J. Roosevelt and Isambard Brunel in experiments on steam propulsion on the Passaic River, New Jersey. They tried a horizontal centrifugal wheel, drawing water from the bottom of the boat and discharging it at the stern. They also tried elliptical paddle wheels.

Mr. F. B. Stevens says that water wheels for mills, driven by the action of the current striking against vanes placed obliquely to the direction of the current, have been used in China for centuries and in Spain since the time of its conquest by the Moors; and before the revolution they were used in this country for mills. This wheel when attached to a vessel and driven by power applied to its shaft is the screw propeller. Colonel Stevens thought himself the inventor of this method of propelling vessels; but he was mistaken. It was proposed by Daniel Berlouni in 1752 and described by David Bushnell in a letter to Thomas Jefferson, dated 1787, in which Bushnell gives an account of his submarine boat with a screw propeller worked by hand. Before 1802 the screw propeller was twice distinctly patented in England by Lyttleton in 1794 and by Shorter in 1800. The devices of both these men are shown in Mr. Stevens' pamphlet.

Colonel Stevens began experimenting with screw propulsion in 1801 and kept it up until some time in 1806. His engines were non-condensing; the boilers were all multitubular, using high pressure steam. His propeller was the short, four-bladed screw now in use. In 1802 he tried on the Hudson a boat 25 ft. long and 5 ft. or 6 ft. wide, propelled by this screw, and got a speed of about four miles an hour at the best. In 1803 he tried another engine and screw, and in 1804 he tried the twin screw propeller which is now exhibited at the World's Fair. The engine has a cylinder 4⅛ × 9 in., boiler with 81 tubes, each 1 in. in diameter, and the boat was 25 ft. long and 5 ft. wide. With this in May, 1804, he got a speed of four miles an hour, and, in fact, we are told that for a short distance he got a speed of not less than seven or eight miles an hour. Dr. Thomas P. Jones, who was superintendent of the United States Patent Office up to the time of its organization under the laws of 1836, says that he was informed in the year 1805 that Colonel Stevens had used a single screw propeller, but found it had a tendency to make the boat move in a circle, a result due to the lessened resistance as the vanes rose toward the surface. Consequently two such wheels were tried side by side, revolving in reverse directions.

In the year 1844, by the directions of the sons of Colonel Stevens, this twin screw engine of 1804 was overhauled by Mr. Isaac Dripps, then general superintendent of machinery of the Camden and Amboy Railroad. This twin screw engine and boilers have been preserved in the Stevens Institute at Hoboken, N. J., and are now in exactly the same condition as when exhibited in New York and on the Hudson in 1844. The boiler has 28 copper tubes, each 1½ in. diameter and 18 in. long, projecting from each side of a rectangular chest. The twin screws are worked by a single cylinder set vertically, a crosshead on the piston rod being attached at either end, by a connecting rod, directly to the crank of the screw shaft.

This attempt to introduce the screw propeller for American steam vessels was given up only one year before the successful application of the paddle wheel by Fulton, and it was unsuccessful, because steam engine building had not been developed in the United States to such a point that it was possible to get the machinery made here, and the exportation of machinery from England was prohibited by law except upon an order from the king's council. Colonel Stevens always maintained that with proper machinery the screw would be found superior to the paddle for seagoing vessels, and in 1816 he presented to the government a plan for a man-of-war propelled by a screw.

The steam propeller was actually brought into practical use by Smith in England and Ericsson in the United States, each of whom considered himself its inventor, and each took out patents in England in 1836 and in the United States two or three years afterward. Both built small screw vessels in England that were successfully tried in 1837 and larger ones in 1839. Smith's vessel, the Archimedes, was upward of 200 tons burden, driven by 90 H. P. engines, and Ericsson's, the Robert F. Stockton, which was smaller, was tried in England under steam, and in 1839 crossed the Atlantic under sail. Both Smith and Ericsson introduced the screw propeller on merchant vessels in 1840 and on war vessels in 1843; Ericsson on the Princeton, Smith on the Rattler.

Apropos of the claim put forward for Colonel Stevens, the *Journal des Transports* wishes the world not to ignore the claims of a Frenchman. That journal says that it is not surprising that the invention of the screw propeller, one of the greatest advances of modern industry, should be disputed, and it appears that last July at Prague the one hundredth anniversary of the birthday of Joseph Ressl was celebrated with appropriate honors, he having discovered the use of the screw propeller. The *Journal* suggests to the Americans who are claiming the honor for Stevens and Czechs who are claiming it for Ressl, that Michael Angelo has left certain designs and sketches which prove conclusively that the conception of the screw propeller had been formed in his mind. "But the true inventor is he who applies in actual work that which was before him only a floating thought. The true creator is the man who does something useful and profitable for humanity. In this view the honor of the invention of the screw propeller belongs neither to the American nor to the Hungarian, but to Pierre Louis Sauvage, a native of Boulogne, to whom the Academy in 1846 solemnly awarded this honor."

ON RAINMAKING.*

By ALEXANDER MACFARLANE, D.Sc., LL.D., Professor of Physics in the University of Texas.

IN this paper I propose first to state briefly what is known about the formation of rain, and then to discuss in the light of that knowledge the different methods of rainmaking which have recently been tried or proposed. While the text books and memoirs of physical science contain a great amount of sound knowledge on the subject, we nevertheless see and hear of professional rainmakers who are no better than the medicine man of the Indians, and we also witness government appropriations expended in operations very suitable to the Fourth of July, but useless as means of extending our knowledge of the formation of rain in the atmosphere.

If a dish filled with water be placed inside a glass receiver, vapor will rise from the water until there is a certain amount of vapor in each cubic inch of the air; the evaporation then stops. The amount of vapor per

* From the Transactions of the Texas Academy of Science, read Dec. 31, 1892.

cubic inch which is sufficient to saturate depends on the temperature of the inclosure; the higher the temperature, the greater is the amount of vapor required; not only so, the amount required increases more rapidly than the temperature. But the amount required to saturate is independent of the density of the inclosed air; when the air is rare, saturation takes place quicker, but there is finally just the same amount of vapor in each cubic inch. This is true even when the inclosure is free of air. For every temperature of the air there is a certain maximum amount of aqueous vapor which it can hold per cubic inch; and conversely, for a given amount of aqueous vapor per cubic inch there is a certain temperature at which the air can just hold it. If the temperature is further lowered, some of the vapor condenses, and the condensed vapor may appear as fog, cloud, mist, or rain.

In what ways may a portion of the air of the atmosphere be cooled? It may come into contact with another portion at a lower temperature, and lose heat by convection and conduction; or it may radiate some of its heat into space or to colder bodies; or it may use up some of its heat in expanding to a larger volume. The last, called dynamic cooling, may be observed in the working of an ordinary air pump. At the beginning the glass receiver is full of air having the temperature and moisture of the air of the room. After a few strokes made in rapid succession a cloud forms inside, and drops of water trickle down the inside surface of the glass. The air left after a stroke expands to fill up the whole inclosed space, and in doing so it draws upon its internal heat. The loss may be so great as to chill the inclosed air below the temperature at which the moisture saturates; if so, a cloud of particles of water appears.

The conditions which determine whether the condensed vapor will take the form of fog, cloud, mist, or rain were investigated first of all by Mr. John Aitken, of Scotland, in a brilliant series of experiments which commenced in 1880.*

What is meant by *fog, cloud, mist, rain*? The particles composing a fog are so fine that they scarcely fall through the air, a cloud is a little coarser in the grain, while a mist is still coarser in texture, and rain is any one of these while falling, whether it be a wetting mist or a drenching rain. Mr. Aitken showed that the dust particles in the air act as nuclei upon which the vapor may condense; if these are present in air cooled below the temperature corresponding to the moisture, condensation takes place immediately. If the dust particles per cubic inch are very numerous, there are many centers of condensation and little water for each; hence fog.

If the number is smaller, the nuclei, being fewer, get a larger share of water; hence clouds. If they are fewer still, mist ensues; and if they are very few, so much water condenses on each nucleus that a heavy drop is formed; hence rain. If the air inside the receiver has been thoroughly freed from dust, and then cooled by expansion below the dew point, a sudden shake in the operations will cause rain to form, the mechanical disturbance taking the place of the dust nucleus. If there were no dust in the atmosphere, the rain would fall from a nearly cloudless sky, a phenomenon which has been observed at some places on the globe.

The dust which is effective as a nucleus for the vapor in the atmosphere does not consist of the coarse motes which may be seen in the path of a sunbeam; it is microscopic, becoming visible only when its size is greatly increased by the load of water. Mr. Aitken said in his first paper:

"In all probability the spray from the ocean, after it is dried and nothing but a fine salt dust left, is perhaps one of the most important sources of cloud-producing dust. It is well known that this form of dust is ever present in our atmosphere, and is constantly settling on every object, as evidenced by the yellow sodium flame seen when bodies are heated."

He further said: "The composition of the dust will also be of great importance in determining its power as a cloud producer, as it is evident some kinds of dust will have a greater attraction for water vapor than others. Fine sodic chloride dust, for instance, we should expect would condense vapor before it was cooled to the saturated point, on account of the great attraction that salt has for water."

"Some kinds of dust have such an affinity for water that they determine the condensation of vapor in unsaturated air, while other kinds of dust only form nuclei when the air is supersaturated; that is, they only form free surfaces on which the vapor may condense and prevent supersaturation."

In 1888 Mr. Aitken invented and developed a method of counting the number of dust particles in any sample of air. These particles are invisible to the highest powers of the microscope; they become visible when loaded with vapor from the supersaturated air in which they were floating. In order to make the number small enough to count, the sample of air to be tested was diluted with pure air 200 times before being drawn into the receiver of an air pump; a plate of silver with a ruled surface had been placed horizontally at a convenient distance from the top of the receiver; the air was cooled by exhaustion, and the density of the vapor kept up by evaporation from water in a dish inside; and the number of drops that fell on the plate was counted. The following results were obtained:

Source of Air.	Dust Particles per Cubic Inch.
Outside, raining	521,000
Outside, fair	119,000
Room	30,318,000
Room, near ceiling	88,346,000
Bunsen flame	489,000,000

Subsequently the pure air at the top of Ben Nevis was found to contain 34,000 per cubic inch.

Suppose, then, that we attempt to produce rain, not in a small portion of the atmosphere cut off from the rest by means of an air-tight receiver, but on a large scale in the unbounded atmosphere. If the air operated on is at a temperature higher than its temperature of saturation, it must be cooled down to that temperature. Further, when the moisture condenses it gives out latent heat, which tends to arrest the process; this latent heat evolved must be removed. It is not, as some rainmakers have imagined, "Pull a trigger, nature will do the rest." The only trigger pulling which experiments warrant as possible consists in supplying the necessary fine dust for nuclei, so that condensation may take place without delay when the air is cooled to its temperature of saturation; or in supplying fine dust from such a substance as common salt, which has a chemical affinity for water, and may be able to accelerate slightly the falling of a shower.

Suppose we take a cubic mile of the air upon which Dyrenforth operated on the night of Friday, November 25, 1892. The record at the weather office in San Antonio at 8 P.M. gave the temperature of the air as 72° F., and the dew point as 61° F. To cool down a cubic mile of that air to the dew point would require the abstraction of as much heat as would raise 88,000 tons of water from the freezing point to the boiling point. To cool it down another 11 degrees would require as much more heat to be abstracted. The amount of water set free would be 20,000 tons, which spread over a square mile would give about 1·4 pounds per square foot, or 0·27 of an inch of rainfall. The amount of latent heat set free by the condensation of that amount of water would raise 100 000 tons of water from the freezing point to the boiling point; and it would be necessary to absorb this heat in order that the rainmaking might go on. I have supposed the cubic mile of air to be kept constant; if the air operated on is constantly changing, the task becomes one of infinitely greater difficulty.

Let us consider now how the different rainmakers propose to accomplish this remarkable feat.

1. *Melbourne.*—In Kansas there is a Prof. Melbourne who has taken contracts to make rain. For the slight sum of $500 he contracted to cause a rainfall of half an inch over a circle of country 100 miles in diameter. He is called the Australian rainmaker. I recollect that some twelve years ago there was an account in the newspapers of attempts at rainmaking in Australia. The country was suffering from prolonged drouth, and I believe that the firing of cannon was actually tried. Probably it was then that Melbourne discovered his method, or borrowed it from the Bushmen. He came to Temple, Texas, hired a shanty on the outskirts of the town, shut himself and an assistant in, and all observers out. All that could be observed from the outside was the issue of some colored gas through a small pipe in the roof of the shanty. The proceedings of this impostor were gravely discussed by intelligent people; so great is the ignorance of physical nature.

2. *Espy.*—Mr. Dyrenforth in his article in the *North American Review*, October, 1891, refers to a plan proposed by Prof. Espy, which was considered by the government of New South Wales:

"In 1837, Prof. Espy, at that time a well-known scientist, proposed a method of compelling nature to loose the moisture which she holds suspended aloft. His plan was to kindle great fires, which would produce a powerful upward current of hot air, and this rising to a great height, where, owing to diminished pressure, it would expand, by the expansion would be cooled, thereby condensing and eventually precipitating its moisture. The Australian government proposed in 1884 to make a test of Espy's theory; but when Mr. H. C. Russell, the goverment astronomer of New South Wales, demonstrated that it would require 9,000,000 tons of coal burned daily to increase by 66 per cent. the rainfall of Sydney, where the average humidity is 73, the project was forthwith abandoned."

Mr. Dyrenforth leaves out one essential point in the calculation. Over what area was the 9,000,000 tons of coal to be burned daily? Anyhow, the result given by the calculation ought to have staggered him in the belief that he could accomplish a comparable result by means of a few insignificant explosions. It is evident that to heat the air produces, in the first place at least, the opposite effect to what is desired; and in any case the subsequent cooling by expansion must first abstract all the heat supplied from the coal before it can take out the further heat required to reduce the air to the temperature of condensation. If moist air could be made to ascend by a process which does not heat it, such process would be more effective and less expensive.

3. *Powers.*—In 1870, Mr. Edward Powers, of Delavan, Wis., published a collection of statistics in a volume entitled, "War and the Weather." By means of these random statistics he establishes the remarkable truism that battles are followed by rain; but he nowhere proves that battles are necessarily accompanied by rain, or that a day of battle is followed more quickly by rain than is a day of no battle. His investigation is a glaring example of the fallacy of *post hoc ergo propter hoc*, further vitiated with the fallacy of neglecting to consider rains which do not follow battles. Without having tested his hypothesis on a small scale, he petitioned Congress to make an appropriation to test it on a large scale. Two hundred siege guns which lie idle at the United States Arsenal at Rock Island, Ill., were to be taken to a suitable locality in the West, and one hundred rounds to be fired from them in each of two operations, the estimated cost of the two operations being $161,000. This shows anyhow that Mr. Powers had some slight idea of the expensiveness of rainmaking. He does not explain how the sound and heat due to the firing of the cannon are to take the heat out of the air in order that the vapor may condense. He does not show how the condensation is to start, but he makes the gratuitous assumption that the latent heat developed by condensation will help on the process instead of retarding it.

Compare Aitken and Powers. The former devises crucial experiments and reasons from the results; the latter deals in so-called facts and cranky arguments. The one puts a distinct question to nature; the other deals in one-sided and random statistics. The one believes that truth may be found by experimenting on the air in his cellar at his own expense; the other lectures and lobbies to get the national Congress to test his crank theory on a large scale at a cost to the country of $160,000. In the one we have a philosopher, in the other a crank.

4. *Ruggles.*—In 1880, Daniel Ruggles, of Fredericksburg, Va., patented a process for producing rain. The invention, as described by Mr. Ruggles, consists of "a balloon carrying torpedoes and cartridges charged with such explosives as nitroglycerine, dynamite, guncotton, gunpowder or fulminates, and connecting the balloon with an electrical apparatus for exploding the cartridges."

Suppose that we have a mass of supersaturated air in the atmosphere, no nuclei being present on which the moisture can condense; Aitken's experiments lead us to believe that the mechanical shock due to an explosion inside or near the mass of air would cause the excess of moisture to condense. But suppose that a cloud has already formed; that fact means that condensation has already started, and that there is no want of nuclei. When the excess of moisture has already condensed, we have no reason for believing that a shock such as that intended by Mr. Ruggles would cause more moisture to condense; for the temperature of the air must first be reduced, and the direct effect of the explosion is to elevate, not lower the temperature.

5. *Dyrenforth.*—As the result of the agitation of Mr. Powers, Congress voted $2,000 to make a preliminary test, and the inquiry fell to the scientists of the Department of Agriculture. They reported that there was no foundation for the opinion that days of battle were followed by rain any more than days of no battle. It was then that Mr. Dyrenforth came forward with Ruggles' plans and offered to make some tests. An additional appropriation of $7,000 was placed at his disposal for a series of practical tests, which were made at Midland, Texas, in August of 1891. A further government appropriation was expended in tests at San Antonio in November of this year.

So little does Dyrenforth understand the nature of the problem, that his plan of operations is as much as possible an imitation of a battle. The ground explosives were fired off in a line facing the advancing clouds; the chloride of potash supplies the place of the smoke from the gunpowder; shells are projected into the air at frequent intervals; the general and his lieutenant even wore cavalry boots. Instead of using a balloon to carry up solid explosives and touching them off when aloft by an electric current, he used cheap balloons filled with hydrogen and oxygen in the proportion required for forming water, and the combination was started by a time fuse attached to the balloon itself. He changed from an explosive to an implosive agent, without apparently being aware of any difference. But there is an important difference. The heat of combination of the oxygen and hydrogen is increased by the falling in of the atmosphere into the empty space produced; while the heat of combination of a solid or liquid changed to a gas is diminished by the cooling of the gas in expanding.

The largest balloon used had a content of nearly 1,000 cubic feet. The combination of the hydrogen and oxygen produced as much heat as would raise 1,300 pounds of water from the freezing point to the boiling point—a very insignificant transformation of energy when compared with the heat required to be abstracted in order to cool one cubic mile of the air to the temperature of saturation. Not only so, it is a transformation of the opposite kind to what is required; for what is required is cooling, not heating. The effect of the falling in of the atmosphere was to develop an additional amount of heat, sufficient to raise fifteen pounds of water from the freezing to the boiling point.

What was accomplished with this goverment appropriation? The test of Friday was made while the atmosphere was threatening to rain: eight balloons, 150 shells, and 4,000 pounds of rosellite were fired off; result, an explosion of a balloon inside a black rain cloud does not bring down a shower. The test of the following Wednesday was made with a clear sky; ten balloons, 175 shells, and 5,000 pounds of rosellite were fired off; result, the sky remained clear. No more tests were made, but the rainmakers the night following, heedless of the probable deluge, fired off twelve balloons, 150 shells, and several thousand pounds of rosellite merely to get rid of them. There was no care taken to observe what might be looked for with some show of reason; the party expected a physical miracle, and they were disappointed.

6. *Chicago Inventor.*—At the time of the San Antonio fiasco, another patented plan of making rain was published, and it was said that Senator Farwell, who has been the main supporter at Washington of rainmaking appropriations, was more satisfied with it than with the concussion plan. It consists in freeing liquefied carbonic acid in the portion of air from which it is desired to extract rain. The carbonic acid in vaporizing and expanding must be supplied with heat, which it will extract from the surrounding air. Here we have the proper kind of agent; but there is the financial question to consider. The amount of heat abstracted by one pound of liquid carbonic acid in volatilizing and taking the temperature of 72° Fahrenheit would change 68 pounds of water by one degree Centigrade of temperature. To reduce the cubic mile of air we considered to the temperature of saturation would require 129,000 tons of carbonic acid; to reduce it the other 11 degrees Fahrenheit would require an equal amount; and to absorb the latent heat would require an additional 150,000 tons. If we take the price of a pound of liquefied carbonic acid at one dollar, the cost, supposing no waste or change of the air, of a rainfall of 27-100 of an inch over a square mile would be more than $400,000.

7. *Pitkin.*—In March of this year I received from Mr. Pitkin, of Kansas City, a newspaper cutting in which he describes two mechanical methods of rainmaking. "The first plan is to use two large canvas tubes or conduits of unequal lengths, their lower ends to be connected over large rotary fans run by steam power; their upper ends attached to balloons, which carry the conduits into the proper strata of air. By the action of the fans the cold air is drawn down one conduit and forced up and out of the top of the second conduit directly into the humid current of air, thus causing one upward and one downward current of air."

This plan supposes that a tube such as described can be held in the air by balloons held captive by ropes, the one at a height of perhaps 2,000 ft., the other at a height of 1,000 ft. This is rather a difficult postulate to realize. But suppose that it is practicable, it is safe to say that the amount of rain precipitated even under favorable conditions would not suffice to run the steam engine.

"The second plan is to use a large sheet of canvas, properly strengthened by netting. The canvas is to be supported in midair (by balloons) at a right angle to the course of a humid current of air; the lower cor-

* "Transactions of the Royal Society of Edinburgh," vol. xxx.

ners of the canvas are to be controlled by ropes, which reach the earth, by means of which the sheet can be drawn to act as an inclined plane. The currents striking against this inclined plane will be deflected from their paths and carried up. They will expand as they ascend, and will be brought directly into contact with the colder air above. This should cause rain, as in the case of mountain condensers. The humid air deflected by a sheet 200 by 400 ft. would be over four billion cubic feet an hour, if the current striking it traveled ten miles an hour. This volume cooled should yield considerable moisture, in addition to which the cumulative effects of precipitation should yield much more."

Mr. Pitkin has calculated the amount of air which would be deflected upward per hour by his vertical sail supported by balloons; but he has not calculated the pressure which this frail structure would have to 'stand. With the wind blowing at ten miles an hour and striking the sail perpendicularly the pressure would be equal to the weight of 100,000 tons. The atmosphere cannot be controlled so easily; it would simply flatten out the sail. A mountain ridge can withstand the pressure; but who can stand the expense of building a mountain ridge?

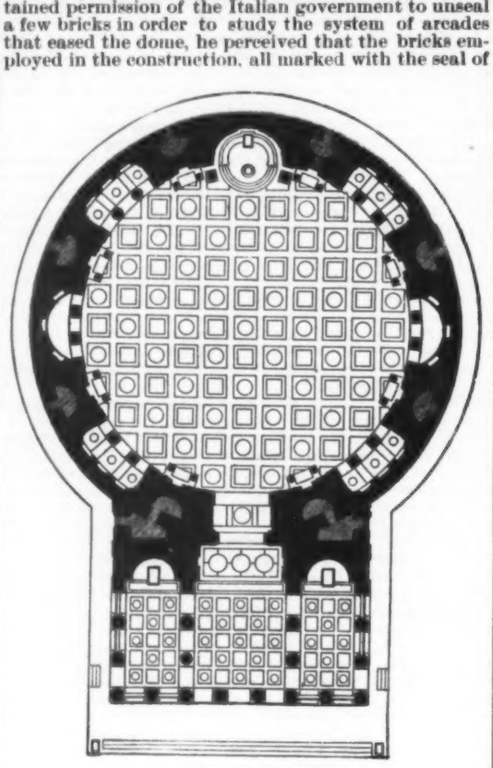
8. *John Jacob Astor.*—Mr. Astor has an invention for making rain which he thus describes: "In the sketch I have shown an air tower erected upon an eminence, such as a cliff or a mountain, and I place in the valley a blower of large capacity, which communicates with the air tower by means of an air trunk of suitable size; and I drive the blower with any convenient power. In the present case I have represented an engine house which incloses the blower, and an engine for driving the same. In lieu of such an arrangement I may provide a tower of sufficient height to convey the air directly from the lower to the higher level, and I may arrange the blower and the driving mechanism in the base of the tower; or I may arrange the blower upon the eminence and extend the suction pipe to the lower level, and connect the discharge pipe of the blower with the air tower. The capacity of the apparatus need not be greater than is required to produce the initial disturbance, or the nucleus of the storm, as when the precipitation of rain begins, the storm will increase from natural causes. To augment the amount of moisture in the air trunk I divert the exhaust pipe of the blower engine into the trunk, thereby surcharging the air in the trunk with the exhaust steam of the engine."

The proposed air tower would be comparable in height to the Eiffel tower, and therefore comparable in expense. Mr. Astor has got the cranky idea that he has only got to pull a trigger and nature will do the rest. It would certainly be advisable to deal economically with the exhaust steam of the engine, for it would probably contain more water than the arrangement could bring out of the atmosphere, notwithstanding the enormous expense of an Eiffel tower.

RESTORATIONS OF THE PANTHEON OF ROME.

AMONG the drawings sent from Rome to the recent Exhibition of the Academy of Fine Arts of Paris, there are several studies of the Pantheon of Rome, one of which particularly, by Mr. Chedanne, offers a peculiar interest by reason of the researches to which the artist has devoted himself upon this celebrated structure. The work is the result of some discoveries made during the course of a study undertaken to verify certain assertions of archæologists.

It appears that Mr. Chedanne had in the first place simply proposed to study the structure of the great dome of the Pantheon, which is doubly interesting by its antiquity and its huge dimensions. Having obtained permission of the Italian government to unseal a few bricks in order to study the system of arcades that eased the dome, he perceived that the bricks employed in the construction, all marked with the seal of



PLAN OF THE PANTHEON OF ROME.

the potter, were of dates varying from 118 to 123 years after Christ, a fact that was in flagrant contradiction to the hitherto admitted hypothesis that the Pantheon, as we see it to-day, was constructed by Agrippa.

Archæologists, in order to defend this idea, rely upon a description by Pliny. Now, Pliny died in the year 79 after Christ. This description, so often cited, could, then, only be that of a structure anterior to the one in the presence of which the artist found himself.

Continuing his researches, Mr. Chedanne had the pavement pierced that covers the floor of the structure, and, at two meters beneath, found another and more ancient pavement. Some researches made in a sewer that passes near the foundations of the Pantheon led to the discovery of a wall far beneath the steps of the present peristyle. This wall, with courses particularly well adjusted, seemed to Mr. Chedanne to belong to the glorious period of the age of Augustus. Further researches led to the discovery that it was covered in places with a facing of marble, separated from the stone wall by a chemise of tufa.

The artist had been particularly struck by the unusual proportions of the columns of the peristyle, which, as well known, are eight in number. As a sequel to researches, studies, and comparisons, he became convinced that such proportions would have been nothing extraordinary if, instead of eight columns, the peristyle had had ten. Making researches in this direction, he discovered the pedestals of the two missing columns.

Certain junctions, particularly those of the corner capitals, had likewise struck him by their coarseness, which contrasted singularly with the delicacy of their sculpture. Had there been used, then, for the construction of the Pantheon that we know, materials that had belonged to the ancient Pantheon whose foundations and pavement Mr. Chedanne had just discovered? A new observation came to support this hypothesis. A striking contrast existed between the inclination of the modillions of the fronton in the antique part preserved and those that had been introduced in the train of the restoration. The former were slightly inclined from the vertical; the others were correctly vertical. Mr. Chadanne conceived the idea of reconstructing the fronton upon ten columns, such as he thought it must have been constructed in the ancient Pantheon. Now, in preserving the same height in the tympan, the angle made by the slope of the fronton, thus reconstructed, with that of the existing fronton was exactly the angle formed by the modillions with the vertical. Mr. Chedanne concluded from this that the present peristyle and its fronton were constructed with the materials of the ancient ones.

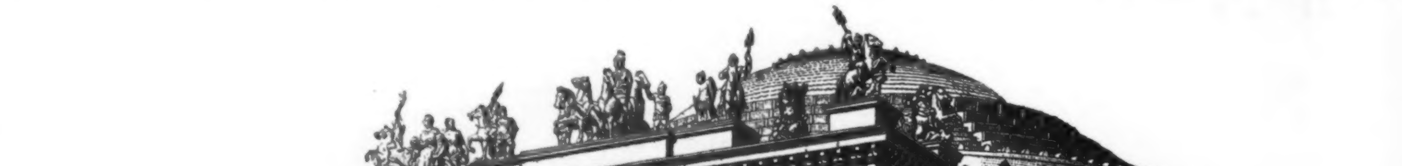
Along with these observations, Mr. Chedanne made some interesting discoveries upon the structure of the dome itself. The excavations that he had made to bring to light the pavement of the ancient monument led to the discovery of a sewer in the very center of the Pantheon designed, he thinks, to collect the rain water falling through the circular aperture in the summit of the dome. It will be recalled that certain archæologists, not knowing how this drainage could have been effected, have expressed the idea that the Pantheon was covered with a sort of lantern.

While waiting to put before the eyes of our readers as large a number as possible of documents relating to this question, we shall recall here the work of our eminent *confrere*, Mr. Chas. Chipiez, upon the same subject.

It will be remembered that Mr. Chipiez had Mr. Poulain, the sculptor, make a plaster model of the Pantheon, on a scale of one-twentieth, which he sent to the United States, and of which we give herewith a general view and plan.—*La Semaine des Constructeurs.*

THE INVENTION OF LUCIFER MATCHES.

WHO was the inventor of the lucifer match? At least as many countries are now disputing the honor of having produced the parent of the first friction match as there were cities claiming to be the birthplace of the Father of Poetry. Under our foreign news recently we mentioned that the Germans want the credit of the invention for one Kammerer, who, they say, beguiled his enforced detention in a fortress, just sixty years ago, with the experiments that resulted in the production of the useful article.



RESTORATION OF THE PANTHEON OF ROME BY MR. CHIPIEZ.

But it is only a few years back since the Hungarians tried to make out that the honor of the invention belonged to a Mr. Ironyi, a countryman of theirs, and a pharmacist to boot. Neither they nor the Germans, however, have succeeded in bringing forward sufficient evidence to establish their claims beyond doubt or cavil; and little more can be said for the French, who, needless to say, have a claimant of their own. This gentleman, M. Sauria, a physician by profession, is said to have invented friction matches in 1831, when a lad at school. He, like the other self-styled inventors, made no money by his discovery, although he was lucky enough in his old age to induce people of certain political influence to support his claim and to obtain from the late President Grevy that last resort of the distressed respectable Frenchman, a *debit de tabac*. The public has since lost sight of the "inventor" in the obscurity of his tobacco shop, but it is quite possible that Dr. Sauria still continues to sell the state monopolized matches of the republic, wondering how it is that their quality has not been improved since he invented them, sixty-odd years ago.

But Dr. Sauria was a little behind the times, for there is no doubt that friction matches were known in this country just after the close of the first quarter of the century. In fact, time will probably show that the real inventor of the lucifer match was a Britisher, though it is very likely that shortly after the discovery was made in this country the secret was also found independently on the Continent.

The first light-bearing matches, as sold in England in 1826, were made of strips of cardboard paper or of flat splints of wood tipped first with sulphur and next with a mixture of chlorate of potash and antimony. They were lighted by being drawn smartly through a piece of folded glass paper. Needless to say, they were expensive, wasteful, offensive to the smell and unsafe. A more effective form of match was introduced soon after by the name of "Congreve light" or "lucifer." It was in England also that machines for cutting the splints forming the body of the match were first brought out, though quite thirty years seem to have elapsed between the invention of matches and the advance of the industry to this stage of machine use. Naturally the retail sale of matches was at first mainly in the hands of pharmacists, who probably were manufacturers themselves in most instances. One of the daybooks of the late Mr. John Walker, who was in business as a chemist and druggist at Stockton-on-Tees as early as the first quarter of the century, for instance, bears numerous entries relating to the sale of "friction lights." The first runs as follows:

Die Saturni, April 7, 1827.

No. 30.—Mr. Hixon.
Sulphurata. Hyper Oxygenate, Frict. 100—1s. 2d.
Tin case — . 2

and from that day onward until September 23, 1829, no fewer than 167 boxes of the same kind were sold by Mr. Walker, who made a solemn entry in Latin each time to record the fact.

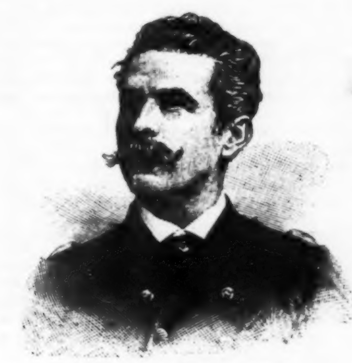
In some quarters, in fact, this Mr. Walker is said to have been the original inventor of the lucifer match, and it is even stated that he hit upon the idea of the preparation while engaged in the manufacture of some chemical compound in his laboratory, after observing that a stick which he had used for stirring took fire when accidentally rubbed upon the hearthstone. Another claimant for the honor of having invented the friction match is Sir Isaac Holden, who is now, at the age of 86, an active politician and business man. Sir Isaac, in evidence he gave some years ago before a Parliamentary committee on the Patents Act, stated that in October, 1829, when engaged as a teacher of chemistry, at Reading, he was in the habit of rising at 4 A. M. and of lighting up, as every one then did, by means of a flint and steel. He often thought of the desirability of improving this cumbersome process, and the idea occurred to him to place sulphur between a piece of wood and some chlorate of potash, the explosive nature of which was well known at the time. He tried this plan in the classroom, and one of his pupils, the son of a London chemist, immediately wrote to his father about the experiment. Shortly afterward Sir Isaac had the satisfaction of hearing that lucifer matches prepared upon his system were being offered for sale in London. He was then urged to apply for a patent, but he thought that the matter was too small to trouble about.

This is another instance of how difficult it is for even people of unusual intelligence to foresee, however dimly, the possibilities of the future when the calculation involves hitherto unknown factors. To estimate even approximately the quantity of matches now produced in the world annually is quite impossible. The statistician would have to take into account not only the European and American production, but also that of Japan and China, where the manufacture of matches is rapidly growing into a great industry. Indeed, it is not impossible that the veteran Sir Isaac Holden himself may witness the time when Japanese safety matches shall have become as formidable competitors to the Continental matches in the British markets as the Swedish article has proved itself to the British for many years.—*Chemist and Druggist.*

THE BRAZILIAN REVOLUTION.

THE struggle between the government under President Peixoto and the rebels under Admiral Di Mello has been waged with considerable violence. As the government control most of the communications abroad, it is not easy to obtain trustworthy news. But so far it looks as if President Peixoto would have enough to do to hold his own. The rebels have bombarded Rio de Janeiro repeatedly, inflicting little damage, says the government with dubious veracity, and the neutral war vessels in harbor are trying to stop the conflict. Admiral Di Mello seems to have gained a good many useful adherents in men and vessels, till the rebel fleet musters thirty ships. The forts are either neutral or favorable to the revolt, that of Santa Cruz alone excepted, while in Rio itself many naval officers refuse to act against the admiral, who is their legal chief. One rebel vessel has left the harbor to attack Santos, and, as the provinces are believed to sympathize with the revolt, the prospects of the government grow worse daily. Our portrait of the president is from a photograph by Pacheco & Filho, and that of the admiral by A. Henschel & Co., both of Rio de Janeiro.—*London Graphic.*

GEN. PEIXOTO, PRESIDENT OF BRAZIL.
Against whom the revolution in Brazil is directed.

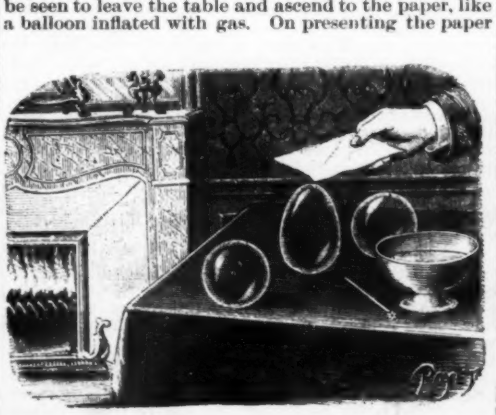


ADMIRAL DI MELLO.
The instigator of the revolt against President Peixoto.

THE DANCE OF THE SOAP BUBBLES.

WE know that woolen fabrics, such as flannel, cloth, etc., if very dry, are capable of serving as a support to soap bubbles without the latter bursting; and in winter, when one has his hands incased in knit woolen gloves, he can play ball with another person similarly gloved, and pass a soab bubble back and forth, the open hand, incased in the glove, serving as a battledore.

Let us place several soap bubbles upon a woolen table cover, and then let us dry a piece of strong paper before the fire and rub it vigorously with a hardish brush, so as to electrify it. Let us place our paper thus electrified over one of the bubbles, and we shall see the bubble elongate and assume the form of an egg; then the electric attraction increasing in measure as the paper is brought nearer the bubble, the latter will be seen to leave the table and ascend to the paper, like a balloon inflated with gas. On presenting the paper successively to the other bubbles, they may be set in motion one after the other, and a most curious dance of soap bubbles be organized.—*L'Illustration.*



EXPERIMENT WITH SOAP BUBBLES.

CHEMISTRY AT THE BRITISH ASSOCIATION.*

AMONG the advantages of the sectional meetings of the British Association are the opportunities they afford for discussions on scientific matters of special interest, and for the exhibition of experiments and specimens to a wider audience than is often available at the meetings of any single scientific society. The meeting of Section B at Nottingham will be chiefly remembered on account of the success of these two features, and it is to them that attention will be specially devoted in the necessarily brief account which follows.

The papers read on the opening day, after the president's address, were chiefly connected with the chemistry of the metals.

Dr. Gladstone gave an account of some tools and ornaments of copper discovered by Dr. Flinders Petrie and Mr. Bliss in Egypt and Palestine. From the chemical examination of some of these it is concluded that their necessary hardness was imparted by the presence of cuprous oxide.

* From *Nature*.

In a paper by H. Harris and T. Turner a furnace used by the natives of Bengal for smelting iron was described. It is a small shaft furnace, about three feet high, and is capable of producing iron of great purity, from magnetic ore and native charcoal, without the addition of flux.

The report of the committee for obtaining an international standard for the analysis of iron and steel was read by T. Turner. The work of the British committee is complete as far as the first four standards are concerned. A report, subject to slight revision, has been issued by the American committee. Their results agree very well with those obtained by the English committee. Standard 5 is held over for later investigation, after the work of all the committees is complete.

G. J. Fowler read a paper on the preparation and properties of nitride of iron. His results confirm those obtained by Stahlschmidt, according to which nitride of iron has a definite composition corresponding to the formula Fe_2N. It dissolves in acid according to the following equation:

$$2Fe_2N+5H_2SO_4=4FeSO_4+(NH_4)_2SO_4+H_2$$

By means of this reaction the author, in conjunction with Mr. P. J. Hartog, has attempted to determine the heat of formation of the nitride. Agreeing experiments show it to be formed with evolution of about three calories.

Specimens of cyano-nitride of titanium obtained from ferromanganese were described and exhibited by T. W. Hogg. This substance has been found present, disseminated in microscopic crystals, in every specimen of high percentage ferromanganese examined by the author. It can be obtained by elutriation of the carbonaceous residue left after solution of the alloy in dilute hydrochloric acid, cupric chloride, etc., and has been identified by qualitative analysis, and by comparison with cyano-nitride of titanium obtained from the blast furnace.

On Friday the communications dealt chiefly with the chemical action of light and the chemistry of the halogens.

Prof. Hummel read the report of the committee for investigating the action of light upon dyed colors. Reds were the colors chiefly examined; of these the eosins were found to be the most fugitive. The great bulk of the fast reds belong to the azo colors. It was especially pointed out that certain reds obtained from natural dyestuffs are more fugitive than many artificial colors.

After the reading of this report, the president called upon M. Meslans, chief assistant to M. Moissan, to demonstrate the method of isolation, and the properties of fluorine. The experiments, which were followed with great interest by a large audience, were eminently successful. On passing a current rather exceeding twenty-five amperes through the solution of potassium fluoride in hydrofluoric acid cooled by the evaporation of methyl chloride to —23°, fluorine was disengaged at the positive pole, its presence becoming evident by the strong smell of ozone. The combustions of silicon, boron, phosphorus, iodine and carbon in the gas were shown with great success.

M. Moissan's apparatus for determining the density of fluorine was shown. After the vote of thanks to M. Moissan and to M. Meslans, proposed by Sir Henry Roscoe, and seconded by Prof. Thorpe, had been carried by acclamation, a telegram, at the suggestion of Sir Henry Roscoe, was dispatched by the president to M. Moissan, congratulating him on the success of the experiments. A reply was afterward received from M. Moissan regretting his inability to be present at the meeting.

Specimens of M. Moissan's artificial diamonds, and of the carbide of uranium, which coruscates brilliantly on shaking the bottle containing it, were shown to the section.

Dr. S. Rideal described the results of his experiments to determine the iodine value of sunlight in the high Alps. The experiments were made at St. Moritz in the Engadine, at a height of about 7,000 feet, the method being exactly in accordance with that recommended by the Manchester air analysis committee. From comparison of the results with some obtained in Manchester at the same time of year (viz., January), it appears that as much sunshine falls upon St. Moritz in one day as upon Manchester in ten. It is this large amount of sunshine, doubtless, which renders St. Moritz so favorable a health resort. It appears from some experiments made in the Alps by Prof. Dixon and Dr. Kohn that above a certain height the amount of sunlight as determined by the liberation of iodine does not increase.

The report of the committee on the action of light on the hydracids of the halogens in the presence of oxygen was read by Dr. A. Richardson. The committee have been investigating the conditions necessary to start the decomposition of hydrochloric acid in presence of oxygen. Experiments show that the presence of metallic salts is of great influence in this respect; the action of metallic chlorides is being specially studied.

The expansion of chlorine and bromine under the influence of light was shown on the screen by Dr. Richardson. For the success of the experiment it is necessary that the surface tension between the liquid, used as indicator of the expansion, and the tube in which it moves, should not be great.

Some interesting experiments made to determine the rate of evaporation of bodies into different atmospheres were described by Dr. Phookan. From the results obtained with naphthalene, it appears that vapors behave quite differently to gases in the manner in which they affect the rate of evaporation of this substance into them.

At the Monday sitting, Prof. P. Frankland read a paper introducing a discussion on the present position of bacteriology, more especially in its relation to chemical science. Prof. Frankland said that the present science of bacteriology really dated from the discovery, some twelve years ago, of methods for obtaining pure cultures. Since then the changes which have taken place have been chiefly in the methods employed for the recognition of bacteria. Microscopical characteristics, even when they have been brought out by mordant staining, have been found to be insufficient for this purpose. This was illustrated by the case of the cholera spirillum, as much difference existing between

the different specimens of this spirillum as between it and totally different species. Morphological have consequently been obliged to give way to chemical and physiological tests.

Chemical tests being as yet few in number are apt to be treacherous, but they are capable of considerable extension. The typhoid bacillus, *e. g.*, will give no reaction with indol, the characteristic of the cholera bacillus, nor will it ferment glucose, but it will coagulate milk. With regard to the chemical products of the action of organisms the following questions suggest themselves: Does the same substance yield different products with different bacteria? Do the same bacteria give rise to the same products with different substances?

Experiments with pure cultures have shown that one and the same bacillus will give identical products with such chemically-related bodies as glycerol, arabinose, mannitol, etc. It appears probable that fermentability is due to the power possessed by a set of substances of yielding the same intermediate body which will give identical end products in all cases. This may explain why only those sugars which contain three carbon atoms or a multiple of three in their molecule appear to be fermentable.

The product of all three varieties of lactic acid by fermentation of glucose by different organisms has been accomplished. The mechanism of their formation was discussed in the light of Emil Fischer's formulæ for the glucoses.

The problems of selective fermentation were next dealt with, the cause of which was to be sought for in the slight differences of solubility, etc., shown by active substances, when in combination with optically active isomeric bodies. One isomer is not found always to be quite unfermentable; in some cases both isomers can be destroyed if time be allowed, one, however, always disappearing first.

Of great interest is what may be termed educational culture, by means of which new characteristics may be artificially impressed upon an organism. A species of bacillus, morphologically identical with anthrax but totally incapable of producing spores, may be obtained by cultivation of true anthrax in broth containing certain salts, such as potassium dichromate or nitrate. The new characteristics will even persist after passage through the bodies of animals. On the other hand, by various means the virulence of pathogenic organisms can be greatly increased, though it has not been found possible to produce pathogenic from non-pathogenic organisms.

It becomes probable, therefore, that naturally occurring bacilli will acquire new characteristics according to alterations in their condition of growth. The occurrence of non-toxic associated with, and morphologically identical with certain toxic organisms, *e. g.*, those of diphtheria, anthrax, cholera, and typhus, is suggestive in this connection.

It is possible that ærobic organisms may become so far modified as to be active in absence of air. Much study is wanted in this direction, which affords special opportunities for observing the conditions of evolution among simpler forms of life.

The application of bacteriology to hygienic matters was next dealt with, with special reference to the bacteriological examination of water.

Finally, the disinfecting action of light under different conditions was spoken of. The generation of hydrogen peroxide, from air and moisture, under the influence of light, discovered by Richardson, would seem to play an important part in this action of sunlight, and the problem partly resolves itself into the study of the conditions of formation of this substance. The effect of different salts in modifying the bactericidal effects of sunlight was touched on, and in conclusion the necessity was urged upon chemists of a knowledge of biology and botany to enable them to carry on bacteriological work, for which the first necessity had now become profound knowledge of chemistry and chemical methods.

In the course of the discussion, which, owing to the length and comprehensiveness of the paper, was not prolonged, Prof. Burdon-Sanderson advocated the establishment of an institute for research where chemists, biologists and pathologists could mutually assist one another. It was resolved that, with his permission, Prof. Frankland's paper should be published in full.

The following papers were read in connection with the subject of discussion, viz.: "Remarks on the Chemistry of Bacteria," by R. Warington, F.R.S.; "Fermentation in Connection with the Leather Industry," by J. T. Wood; and "Some Ferments Derived from Diseased Pears," by Dr. G. Tate.

On Tuesday morning Prof. H. B. Dixon opened what proved to be a most interesting discussion on explosions in mines, with special reference to the dust theory.

Opinions on this subject may be grouped under three heads:

(1) That although it is possible to stir up and ignite a cloud of dust, the flame dies out and is not explosive—*i. e.*, that a mixture of coal dust and air *per se* is not explosive. This is the view held by Mallard and Le Chatelier.

(2) That although a mixture of coal dust and air *per se* is not explosive, a very slight addition of fire damp, insufficient to be recognized by the Davy lamp, will render the mixture explosive. This view is supported by the experiments of Abel.

(3) That a mixture of fine coal dust and air is *per se* explosive, and that the explosion once started in such a mixture can be propagated as far as the mixture extends.

Prof. Dixon then gave a brief history of the subject, dealing chiefly with the characteristic features presented by certain great mine explosions, and the experiments and results of the committees in different countries who have studied the question. The explosion in the Seaham Colliery in 1880 was specially dealt with. By means of a diagram it was shown that the only portions of the mine untouched by the explosion were those which were damp, and therefore free from dust. It was impossible to explain the method of propagation of this explosion otherwise than by the dust theory. Mr. Hall's experiments in 1891, in which a cannon was fired at the bottom of an old shaft in which coal dust was suspended, were described, and photographs of some of the explosions shown. In some cases explosions could be brought about by these means, in others not, suggesting that the explosion was largely dependent on the character of the coal dust. In conclusion, the importance of carefully testing for low percentages of fire damp was pointed out, and also the possible advisability of using the fuses containing ammonium nitrate, recommended by the French commission on account of their low temperature of detonation.

At the conclusion of Prof. Dixon's address, Prof. Clowes exhibited his portable safety lamp, with hydrogen attachment for delicate gas testing, described in the proceedings of the Royal Society, vol. lii.

Mr. Galloway followed with a vigorous defense of the coal dust theory. The dusty mines are always the deep mines which, owing to their greater warmth, are dry. In no mine of a less depth than 600 feet has any great explosion occurred. In damp mines explosions are limited in their area, while in dry mines they may ramify sometimes for a mile or so. In his opinion, the experiments which had given rise to the belief that stone dust could convey explosions should be repeated. It was to be noted in drawing conclusions from laboratory experiments, that the conditions obtaining in the mine were more favorable to the production of explosions, the temperature being higher and the air drier and denser. In conclusion, he showed that the anticipated evils resulting from watering the mine do not occur.

Mr. Hall, in the course of his remarks, said the higher the quality of the coal, the greater was the liability to explosion. He hoped that it had been proved to the satisfaction of practical people that coal dust and air alone were competent to produce explosion.

Prof. Thorpe said that in an explosion caused by flour dust, which had reduced a mill to a heap of dislocated bricks, he had received an object lesson which had quite converted him to the coal dust theory. Experiment had shown him that coal dusts varied greatly in their capacity of exploding; some will not explode under any conditions, while others he could at any time explode with certainty.

Mr. Stokes declared himself in favor of the second of the three opinions mentioned by Prof. Dixon. It should not be concluded that large amounts of gas could not rapidly accumulate in pits. In one mine, in which for four years no gas had been found, an evolution of gas took place which in twenty-five minutes was sufficient to fill the workings. The lamps being good, no explosion took place; had it done so, all the evidence would have been in favor of its origin being due to coal dust. He looked for remedial measures in improved explosives and safety lamps, rather than in watering, which he considered insufficient to more than moisten the surface of the dust, unless carried to an impracticable extent. Others having spoken, mainly in favor of the coal dust theory, Prof. Dixon, in reply, said that he was glad that all mining engineers now seemed to recognize the dangerous character of coal dust.

After the above discussion, Prof. Smithells showed by experiment that iodine vapor will glow on heating, supporting his contention that the luminosity of flame may be due to incandescent gas. The papers on organic chemistry read at Nottingham were very few, viz.: "On the Red Coloration of Phenol," by Dr. C. A. Kohn; "On the Salts of a New Sulphurea Base," and "On Citrazinic Acid," by W. J. Sell and T. H. Easterfield; and "On Ethylbutane Tetracarboxylate and its Derivatives," by Bevan Lean. In the course of the latter investigation two isomeric modifications of di-benzyl adipic acid have been obtained. The report of the committee on isomeric naphthalene derivatives was read. The work done has been chiefly in connection with the orientation of mixed nitro and halogen derivatives.

The following pieces of apparatus were described, viz.: An apparatus for extraction for analysis of gases dissolved in water, by Edgar B. Truman, and a new form of Bunsen and Roscoe's pendulum actinometer, by Dr. Richardson and J. Quick.

WHALEBONE AND WHALEBONE WHALES.

By R. Lydekker, B.A. Cantab.

Seeing that the substance so called has nothing in common with true bone, many zoological writers object to the use of the term "whalebone;" and they have accordingly proposed the substitution of the word "baleen," which has been specially coined for the purpose. To our thinking, there is, however, no necessity for this substitution of a word of foreign origin for such a well known English name, any more than there is for replacing the native term "black lead" by its foreign equivalent "graphite." Everybody knows what is meant by whalebone or black lead, while comparatively few are familiar with the terms "baleen" and "graphite;" and as the two former are every bit as good as their foreign substitutes, we prefer to employ them. If, indeed, there should exist any person so misguided as to imagine either that whalebone is equivalent to the bone of whales, or that black lead has any sort of affinity with lead, we fear that the substitution of the terms "baleen" and "graphite" would not much aid in removing their ignorance.

The substance which we accordingly take leave to call whalebone is one of the chief essential characteristics by which the whalebone whales are distinguished from the toothed whales. As all our readers are probably aware, this substance is attached to the upper surface of the mouth of the whale, from which it depends in the form of a series of parallel, narrow, elongated, triangular plates, placed transversely to the long axis of the mouth, with their external edges firm and straight, but the inner ones frayed out into a kind of fringe. The longest plates of whalebone are situated near the middle of the jaw, from which point the length of the plates gradually diminishes toward the two extremities, where they become very short. There is, however, whalebone and whalebone, and whereas in the Greenland whale the length of the longest plates varies from some ten to twelve feet, while the total number of plates in the series is about three hundred and eighty, in the great rorquals, or fin whales, the length is only a few inches, while the number of plates is considerably less. To accommodate the enormous whalebone plates of the Greenland whale, the bones of the upper jaw are greatly arched upward, while the slender lower jaw is bowed outward, thus leaving a large space both in the vertical and horizontal directions, the transverse diameter of the space being much wider below than above. When the mouth is closed, the plates of whalebone are folded obliquely backward, with the front ones lying beneath those behind them; but directly the jaws are opened, the elastic nature of this wonderful substance causes it to spring at once into a vertical position, and thus form a sieve-like wall on both sides of the mouth, the thin ends of the plates being prevented from pushing outward by the stiff lower lip which overlaps them. By elevating its enormous fleshy tongue within the cavity thus formed, the whale causes the inclosed water to rush out between the plates, leaving such small creatures as it contained lying high and dry on the surface of the tongue ready for swallowing.

In structure, whalebone (which, by the way, although black in the Greenland whale, is white in some of the other species) is of a horny nature, and grows from transverse ridges on the mucous membrane of the roof of the mouth; being, in fact, nothing more than an ultra-development of the ridges on the palate of a cow, hardened and lengthened by an excessive growth of a horny superficial or epithelial layer. The whole of this stupendous horny growth takes place, however, after birth, young whales having smooth palates, with no trace of the horny plates. Although at birth young whalebone whales show no traces of the substance from which the group derives its name, they equally exhibit no evidence of the presence of teeth. If, however, their jaws be examined at a still earlier stage of development, it will be found that there are a number of small teeth lying within a groove beneath the gum on each side of both the upper and the lower jaws. Previous to birth these teeth become absorbed, and thus never cut the gum. Their presence in this transitory stage is, however, of the deepest interest to the evolutionist, since they unmistakably indicate the derivation of the whalebone whales from ancestors provided with a full series of functional teeth. This, however, is not the whole of the story these rudimentary structures have to tell. From the recent investigations of Dr. Kukenthal, it appears that in addition to the above mentioned tooth germs, the jaws of very young whales likewise exhibit traces of a still earlier deciduous series of milk teeth; thus showing that the former correspond to the permanent series of other mammals. Accordingly, these tooth germs do not represent the functional teeth of the toothed whales, which, as we have seen in the article on that group, correspond to the milk teeth of ordinary mammals. Even more remarkable are certain observations relating to the structure of these tooth germs. It has been shown, indeed, that the teeth in the latter part of the series, when first formed, consist of a number of adjacent cusps, and that as development proceeds these cusps become completely separated from each other so as to constitute distinct individual teeth of a simple conical form.

This discovery is of the very highest import, since it serves to indicate how the numerous simple conical teeth of the dolphins and other toothed whales have probably been derived by the splitting and subdivision of originally complex cusped teeth more or less closely resembling those of the extinct zeuglodonts.

Being primarily distinguished from the toothed whales by their total absence of teeth after birth and the presence of whalebone in the adult condition, the whalebone whales present certain other distinctive characters to which we may now briefly allude.

In the first place, the whales of this group differ externally from all those furnished with teeth in that their nostrils open externally by two distinct longitudinal slit-like apertures; while, if we cut into the head we shall find that there is a distinct organ of smell, of which all traces have disappeared among the toothed whales. Moreover, instead of the skull being invariably unsymmetrical in the region of the nose, as it is in the latter group, it retains the normal symmetry; while, instead of the mere nodules which in the toothed whales represent the nasals of other mammals, in the whalebone whales these bones are fairly well developed. Moreover, the lower jaw of any member of the present group may always be distinguished from that of a toothed whale, not only by the absence of teeth, but likewise by the circumstance that each of its branches is much bowed outward in the middle, while their anterior extremities are connected together only by ligamentous tissue, instead of by a bony symphysis of greater or lesser length. Many other points of difference between the two groups might be cited, but we have especially referred to those mentioned above, for the reason that while the presence of whalebone indicates that in one respect the members of this group are more specialized than their toothed cousins, in regard to the structure of the skull in the region of the nose and the retention of an organ of smell, as well as in the double apertures of the nostrils, they depart less widely from the ordinary mammalian type. And it is from this evidence that zoologists regard the two main groups of whales as being widely divergent branches from a common ancestral stock, if, indeed, they do not go so far as to consider that each has had a totally independent origin.

With regard to the number of forms by which they are represented, the whalebone whales are far less numerous than the toothed group, while the whole of them are included within a single family. What the group lacks in number is, however, amply made up by the great bodily size of its various representatives. Among the toothed whales, the sperm whale alone attains gigantic dimensions; whereas in the present group there are several species, such as the Greenland whale, which nearly equal that enormous creature in bulk, while two of the rorquals far surpass it. This, however, is by no means all, for whereas the great majority of the dolphins and porpoises are relatively small cetaceans of less than twenty feet in length, the smallest member of the present group is the New Zealand pygmy whale, which attains a length of twenty feet, while next to this comes the lesser rorqual, whose length is frequently close on thirty feet.

Of the various genera of this group, the most specialized are the typical or right whales (*Balaena*), in which the black whalebone is far larger and more elastic than in any of the others, except the pygmy whale,

while, in order to accommodate it in the mouth, the skull has the palate narrower and much more highly arched, and the two branches of the lower jaw more outwardly bowed than in the other members of the group. Externally, these whales—which are commercially of far greater value than the undermentioned rorquals—are characterized by the inordinately large dimensions of the head, by the smooth throat, the moderate length of the flippers, and the total want of a back fin. So gigantic, indeed, is the size of the mouth of these whales that its capacity actually exceeds that of the whole of the other cavities of the body; and yet the size of the throat is so small as almost to justify the common nautical saying that a herring will choke a whale. There are but two well-defined species of right whales, viz., the Greenland or Arctic whale (*B. mysticetus*), and the southern right whale (*B. australis*), the latter of which was nearly exterminated some centuries ago in the Atlantic by the Basque whalers, while the former is only too likely to share the same fate at the hands of their modern successors in the Arctic seas. Of the two, the Greenland whale is decidedly the more specialized, having a much larger head and longer whalebone, and is in this respect *facile princeps* among its tribe; although, as it only measures from forty-five to fifty feet in length, it is inferior in point of size to the rorquals. The skeletons of both these whales are characterized by the whole of the vertebræ of the neck being welded together into a solid mass; and the same feature is exhibited by that of the pygmy whale (*Neobalæna*) of the Australasian seas, which, as already mentioned, is a mere dwarf among giants, as it does not exceed some twenty feet in total length. Agreeing also with the right whales in its smooth throat, the pygmy whale differs by having a small hook-like fin on the back, while its long and elastic whalebone is white instead of black. Far larger than the last, the great gray whale of the Pacific (*Rhachianectes*) forms a kind of connecting link between the right whales and the rorquals, having the smooth throat and finless back of the former, while its whalebone is even shorter and coarser than in the latter; the palate consequently is but little vaulted, and the entire head smaller in proportion to the body.

The remaining whales of this group are divided into humpbacks (*Megaptera*) and rorquals or finners (*Balænoptera*), both of which are characterized by the presence of a number of parallel groovings or flutings in the skin of the throat, by the presence of a back fin (whence their name of finners or fin whales), and also by the shortness and coarseness of their whalebone, which is generally of a yellowish color. Their flukes are, moreover, less expanded than are those of the right whales; while, as already said, their heads are relatively smaller and lower, with the cavity of the mouth much less vaulted. In their skeletons, the vertebræ of the neck differ from those of the right whales in being longer and completely disconnected from one another; and in this respect the Pacific gray whale holds a position intermediate between the two groups. Humpbacks, of which there is but a single species, are specially characterized by the shortness and depth of the body, which behind the shoulder rises above the level of the back fin, and by the exceeding elongation and slenderness of the flippers, which are about equal to one-fourth the total length of the animal. The female humpback, which somewhat exceeds her partner in size, attains a length of from forty-five to fifty feet, or about the same as that of the Greenland whale. An enormous whale, believed to belong to this species, became some years ago entangled in the telegraph cable line off the coast of Beloochistan with three turns of the cable round its body. On the other hand, in the rorquals, the body is long and slender, while the flippers are small and pointed. Of the four well established species of this genus, the blue or Sibbald's whale (*B. sibbaldi*)—the sulphur bottom of the American whalers—enjoys the proud distinction of being the largest of all known animals, whether living or extinct, attaining the enormous length of from eighty to eighty-five feet; while the common rorqual (*B. musculus*) comes in a good second with a length of from sixty-five to seventy feet. Both the others are, however, considerably smaller.

As regards their distribution in time, right whalebone whales have left their remains commonly enough in the pliocene strata of all parts of the world, and they probably also occur in those of the miocene period; but, although a single vertebra from the eocene beds of Hampshire has been assigned to a member of this group, there is at present no decisive evidence that they had come into existence at such an early date. Since most of the pliocene species are of smaller dimensions than their living representatives, it appears that these marvelous creatures had only attained their maximum size shortly before the time when their very existence was to be threatened by the relentless hand of man.

Formerly the only members of this group of whales which were thought worthy of general pursuit were the right whales; the shortness of their whalebone, coupled with their relatively small yield of oil, and their tremendous speed, rendering the rorquals scarcely worth the trouble and risk of hunting. Of the two right whales, the Greenland species, as being the more abundant, received the greatest share of attention; and so relentless has been its pursuit that it is now either wellnigh exterminated from many of its ancient haunts, or has retreated still farther north to regions almost impossible of access. As showing how the constant persecution in the Greenland seas has told upon the size of the comparatively few remaining individuals of this species, it may be mentioned that the eleven specimens killed there during the season 1890-91 yielded an average of less than 8 cwt. of whalebone, whereas in five taken during the same season in Davis Strait the average yield was more than double this amount. In consequence of this diminution in the number and size of the Greenland whale, the price of whalebone has of late years gone up enormously; and whereas some time ago whalebone of over six feet in length sold at £1,000 per ton, in 1892 it had reached the enormous price of upward of £2,800 per ton. The southern right whale yields a smaller quantity of less valuable whalebone, now selling at from £1,600 to £1,800 per ton, the quantity obtained from a well-grown example varying from 800 to 1,200 pounds. The amount of oil produced by a whale of the same species averages from eight to fourteen tons, of which the present market value is about £28 per ton. If the unfortunate animals are not allowed some respite, it is only too probable that the supply will before long cease altogether.

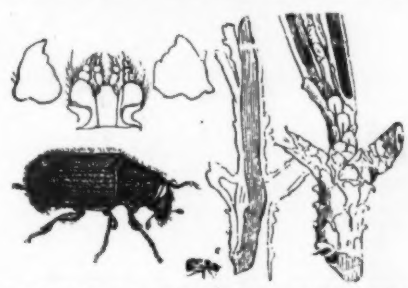
As another result of this growing scarcity of the Greenland whale, attention has been directed to the previously despised rorquals and humpbacks, the employment of steam whaling vessels and the use of explosive harpoons having enabled the whalers easily to cope with the greater speed of these cetaceans. At Hammerfest, a special "fishery" has, indeed, been established for the capture of rorquals, where the capture of these animals is now large. The products of these whales are, however, nothing like the value of those of the Greenland species; and if the latter, together with the southern right whale, be so nearly exterminated as to render pursuit no longer profitable, the supply of long whalebone will absolutely come to an end.

Cannot, we ask, something be done to check this short-sighted greed before the opportunity is forever lost?—*Knowledge*.

INSECTS INJURIOUS TO FOREST TREES.

SURELY these are greatly on the increase in this country. During the past summer I have visited large extents of woodland in at least three of the south midland counties, Northamptonshire, Buckinghamshire, and Bedfordshire, and in every instance the same question has been asked me, What remedy can you suggest to lessen the depredations of these injurious insects? No coniferous tree would seem to escape, each one having some particular insect or fungoid pest that renders whole woods unfitted for any economic or ornamental purpose.

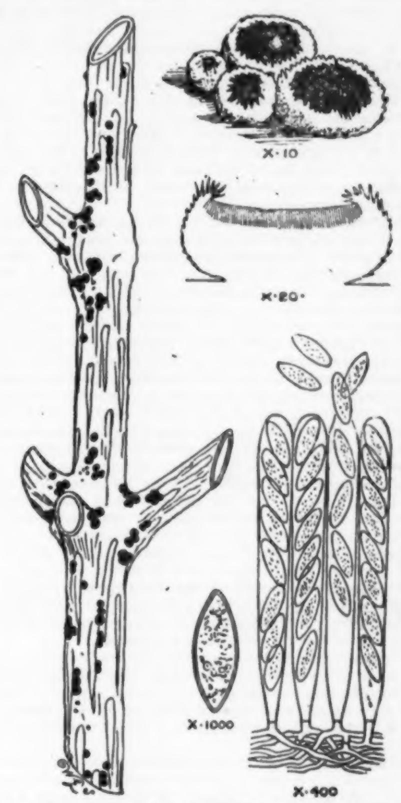
The Scotch pine suffers severely from the ravages of that dread insect, the Pine beetle, Hylurgus piniperda. The spruce is being killed out or rendered very unsightly from the attacks of the pineapple gall or spruce gall (Chermes abietis), while the larch is being killed wholesale in many woods by the larch canker, and which is due to the minute fungus, Peziza Wilkommii. But this is not all, for the deadly insect Liparis monacha has likewise made its appearance; and others of quite as destructive propensities have, during the past unusually warm and dry summer, been detected in no small quantities. Tomicus typographus, Pissodes Pini, and P. rotatus have also been recognized, and several others are under examination.



PINE BEETLE (HYLURGUS PINIPERDA).
Much magnified, and pine shoots bored by the beetle.

The pine beetle is present in unusual quantities—indeed, to such an extent do the ravages of this insect extend that acres of young Scotch fir are either completely killed out or crippled to such an extent that their future value is hardly worthy of consideration. Young trees, of course, suffer most; but after the age of, say, twenty to twenty-five years, the attacks are less persistent, probably owing to the shorter and more matured growths of the trees.

The special form of injury done to pines by this beetle consists in its boring into the young shoots for feeding purposes, and which is effected by working a lateral hole in the twig, usually at about six inches from the tip, and boring upward for an inch or two through the pith, and which it only quits at the beginning of winter for purposes of hibernation. This tunneling so weakens the shoot that with the first storm it breaks readily over, either at the point where an entry or exit was effected, and occasionally where the beetle is present in quantity, the ground becomes strewn with the fallen shoots, or what looks worse still, they hang from the branch tips as if these had been riddled with shot. I feel confident that in Bedfordshire, at least, the great increase of this particular beetle can be attributed solely either to neglect or a want of knowledge of the life history of the insect. Few persons seem to be aware that this beetle does not, as a rule, hibernate in standing trees, but chooses fallen trunks or branches, dead or dying trees or stumps, in which to deposit its eggs; and this of itself should make those in charge of woods and plantations very careful that all branches or prunings, in fact every kind of felled wood, are removed from the ground as soon after being cut down as possible. Prevention in this case is far better than an after cure, for once the insect gains a footing, the most stringent measures are required to place a check upon its depredations. A very common practice, too, is to follow a crop of Scotch fir with that of the same kind; but a careful examination of such woods will soon betray the fallacy of this



LARCH FUNGUS (PEZIZA WILKOMMII).

course of forest management. Apart altogether from the fact that recropping with the same species of tree is inimical to the growth of the plantation, the stumps of the old firs that are left in the ground serve as the best possible breeding place for the pine beetle, and the newly planted trees the best feeding ground.

Wherever the Scotch, Austrian, and Corsican pines are grown in quantity, but particularly when old and young breadths of the trees occur in close proximity, the greatest care is necessary to prevent the inroads of the pine beetle, and this can only be done by a thoroughly well worked out system of forest management.

Cleanness and neatness, by having no dead and dying wood and lopped-off branches lying about in the woods, and by attending to the general health of the trees, will alone assist in keeping this insect pest at bay. Once it gets a footing in large breadths of timber, extermination, be it only partial, is a task of the greatest difficulty, and attended by heavy expenses; indeed, the only sure way in such a case is the drastic measure of cutting down the infected trees, and burning them on the ground. This, too, is a measure requiring the greatest care, and a deep insight into the life history of the insect. To cut down and burn the trees in winter is lost labor, in so far as concerns the destruction of the insect, for the beetle at the beginning of winter quits the shoots, and hibernates in moss, etc., or low down at the base of the trunk. By collecting old trees and branches that are lying on the ground not later than the beginning of June, and carting these away, or carefully burning them in the wood, great good may be brought about, the number of beetles present being greatly diminished by such a course of procedure. The felling infested trees that have been ringed and left as traps in February, when the beetles are breeding in the bark, is another excellent method of lessening their numbers, but such work requires to be very carefully gone about.

In connection with the pine beetle it should be remembered (1) that it never breeds in the shoots where

SPRUCE GALL (CHERMES ABIETIS).

PINE SAW FLY (LOPHYRUS PINI).

it feeds, (2) that its eggs are laid in dead and dying logs on or near the ground, early in April, and (3) that the larvæ appear as perfect beetles in June and July.

The spruce gall aphis (Chermis abietis) is very abundant all over England, and this season in particular its depredations have been increased to an alarming extent. When abundant, the general health of the trees is seriously affected, while in every case crippling and distorting of the branches is brought about by this much-dreaded insect. Having passed the winter in crevices of the bark, the Chermes appear in the spring as ocher-colored wingless insects, and attach themselves to the young and tender leaves of the spruce. A mass of eggs is laid on the tender shoot, usually where two twigs meet, the larvæ of which, when hatched, tap the shoot with their beaks, this causing the swelling known as the spruce gall, and which resembles a small fir cone. In August the winged insects leave the "cones." To cope with this insect is a by no means easy task, although in the case of single specimens, hand picking and destroying the galls in June or July will be found productive of a great amount of good.

Probably the worst enemy to young conifers, and one that unfortunately is by no means uncommon, is the pine weevil (Curculio (Hylobius) abietis). The beetle attacks nearly all the pine tribe, as well as the larch, spruce, and at least two species of cypress, the depredations consisting in the eating of the bark of the shoots and tender twigs. To such an extent is this gnawing of the bark carried on that frequently whole branches are rendered barkless in a few days, an unusual flow of resin being the result. Usually only young fir trees are attacked, up to, say, the age of ten years, and nursery stock often suffer to a great extent.

By keeping the woods free of dead and dying twigs and logs, no breeding places will be found, and so the extermination of this, like most other beetles, is a matter of no great difficulty. Another occupant of our woods and forests is the pine saw fly (Lophyrus Pini), its damages being extended to the partial devouring of the needles of the infested tree.

The larch miner (Coleophora laricella) feeds on the center of the larch needles, which it mines into, causing these to turn yellow and drop off in great quantity. This may not kill the tree, but going on for year after year the attacked specimens rarely have a healthy appearance. It is very plentiful in England.

Another very common occurrence in our pine woodlands is to see the shoots deformed and twisted, and the terminal buds stunted and falling off—an evil that is due to the attacks of the pine shoot moth (Retinia buoliana). The larvæ live in the trees through the winter.

There are many other insects that cause considerable damage to our coniferous trees, but the above may be considered as the principal or worst forms with which the forester has to cope. The "larch disease," or "larch canker," as it is commonly known, is, unfortunately, very much on the increase in this country; indeed, during my experience I have never seen such widespread devastation as is to be met with this season. It is due to a minute fungus known as Peziza Wilkommii, and which spreads wherever a footing can be got, with terrible rapidity.

The main point to attend to in coping with this malady is to preserve the larch plantations in as healthy a state as possible, and to do this, the following rules should be rigidly observed, remembering that the fungus can only find a footing where the bark of the tree has met with injury in one way or another.

1. Plant the tree only on suitable soils.
2. By careful management, keep the trees in as healthy a condition as possible.
3. Choose healthy, strong stock to start from; and—
4. In collecting larch seed for propagating purposes, select only such as has been matured by a winter's frost, and from healthy trees in the prime of life. (No. 4 should be rigidly observed, for owing to neglect of these precautions deterioration of the larch has long been going on.)

As showing the widespread damage that has been inflicted on coniferous trees of late I might specially refer to a case in South Wales, where thousands of larch trees have been destroyed by the above fungus; to numerous cases in England, where the pine beetle is causing widespread devastation in the Scotch fir woods; and to serious damage in Ireland by several of the other insects named in this paper.

Abroad many striking examples might be mentioned, such as in East Prussia, Poland and Russia, where in the fifteen years, from 1853-68, the spruce was killed over an area of 7,000 square German miles; and two years ago in Bavaria, where damage to the trees amounted to fully £40,000. In both instances that destructive insect, of which we are by no means free in this country, Liparis monacha, was entirely to blame.

The great importance of the attack has caused owners of woodlands in this country to look better to the general health and cleanliness of their woods and plantations than has ever before been the case; and the numbers of specimens of insects that have been sent for inspection and naming also proves that a great additional interest is being awakened in the matter.

In conclusion, it may be stated that, as a rule, so as to keep these insect pests in check, no loppings or windfalls should be allowed to lie about in the woodlands, such only affording the best of all breeding grounds, and consequent spread of the evil.—*A. D. Webster, in the Gardeners' Chronicle.*

A POISONOUS FUNGUS.

Agaricus (amani'a) phalloides, Fries.—There is rather strong evidence that this is one of the most poisonous of British fungi, if not really the very worst. It resembles a little the celebrated fly agaric, but the brilliant red of that species is in itself a warning, while the present is more subdued in its coloring, and much more common. In the autumn nearly every wood produces them in plenty, and there is no doubt that Dr. Plowright traced some case of mushroom poisoning to this source. It is rarely that the species causing the mischief can be accurately determined after these accidents, but fortunately Dr. Plowright was a practical mycologist, and soon discovered the cause. We have considered it of advantage to give a figure of this enemy of the unwary, with a few particulars of its history. The pileus, or cap, is from three to four inches broad, with rather a viscid skin, soon becoming expanded and rather flat. Sometimes the top is quite naked, at other times patches of the volva-membrane, irregular in size and shape, are adherent. When growing exposed to the sun, the color is whitish, or pale lemon yellow, but in more shady places with a dull greenish tint, or pale olive. The gills are free from the stem and white, broadest in the middle, and narrowed toward each end. The stem is from three to five inches high, solid at first, but becoming hollow, bulbous at the base, with a large drooping white collar or ring toward the top, and a volva or sheath at the base, the lower portion of which is grown to the bulb, the upper margin being torn and loose. When quite young, the cap is inclosed within a membranaceous coat or volva, with the form of an egg, but with the growth and elongation of the stem, this volva is broken irregularly, and the young cap rises on its stem, carrying up with it fragments of the torn volva attached to its surface, while the residue remains like a ragged membrane attached to the bulbous base. While still fresh, this fungus has very little odor, but soon after being gathered it smells more strongly, becoming more or less stinking in decay. The odor faintly resembles that of the stinkhorn (phallus), and hence the name.

There is a variety which is pure white, sometimes called a distinct species, under the name of Agaricus vernus, which only seems to differ in color, and less fœtid odor, but it is equally dangerous. In both forms

STINKING WARTED CAPS—AGARICUS PHALLOIDES, PALE YELLOW OR GREENISH.

the spores are white and the substance rather soft and fragile, so that we cannot imagine how any sane person can possibly confound them with the common mushroom.—*M. C. Cooke, in The Gardeners' Chronicle.*

THE KADAMBA TREE.

THIS tree is indigenous to Ceylon, and is known among botanists as *Anthrocephalus Cadama* (the Kadamba of the Tamils). It has an erect stem with many branches, the flowers, which have a peculiar sweet smell, forming a small globe. The fruit is about the size of an orange. This is eaten by the poor natives in India, while the leaves are given to cattle as fodder. The bark is considered to be of great value as a febrifuge and tonic. Its taste is bitter and astringent. The fresh juice of the bark is applied to the fontanelles of children when that soft portion of the head sinks. At the same time a small quantity mixed with cumin and sugar is given internally. The juice of the bark mixed with an equal quantity of lime juice, opium, and alum has been applied with great benefit round the orbit of the eye to subdue inflammation. The tender leaves, when applied in the form of a paste, resolve glandular swellings, and the large leaves prove an efficacious remedy for eczema. A decoction of the leaves is used as a gargle in cases of apthæ and stomatitis. The fruit is considered to be cooling, a destroyer of phlegm and impurities of the blood. The wood of the Kadamba tree is of great economic importance, is soft, yellow-colored, and even-grained, weighing about 40 pounds per cubic foot. It is used for building purposes in Assam, and may be used as material for beams and and rafters, being also good for joiner's work. In Calcutta it is one-third as cheap as mango wood. Kadamba trees grow wild throughout India, and are principally used for fuel. The closely allied *Manjal-Kadamba*, the *kolon* of the Sinhalese (*Adina Cordifolia*), and Nir-Kadamba or Chelembe, the Helamba of the Sinhalese (*Stephegyne parvifolia*), are sometimes used by carpenters in Ceylon. The wood of the former is extremely fine and like that of the box tree, being light and durable, though it does not stand damp well. It is used in Bombay for planking for the floors of houses. The former, which is of a light chestnut color, fine and close grained, has also been used for flooring planks, packing boxes, and similar purposes.—*Indian Agriculturist.*

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